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ORANGE TREE - DENT'S ORCHARD - WHANGAREI.
From a photograph.

TREATISE AND HANDBOOK

OF

ORANGE-CULTURE

IN

AUCKLAND, NEW ZEALAND.

BY

GEO. E. ALDERTON.

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North Auckland:

Know'st thou the land where the lemon-trees bloom,
Where the gold orange glows in the deep thicket's gloom,
Where a wind ever soft from the blue heavens blows,
And the groves are of miro and nikau and rose?

WELLINGTON:
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1884.

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PREFACE.

WITH a view of encouraging the more extensive culture of Citrus fruits in the northern portion of New Zealand, and of aiding planters with reliable information on the subject, the author of this handbook was empowered by the New Zealand Government to visit New South Wales in 1884, to personally inquire into and report upon the methods of cultivating the orange, as pursued there. The result of that inquiry is embodied in the following pages, as are also all the data which the writer has been able to obtain from different sources of information, after a diligent research extending over some years.

The author was largely indebted to the Chief Secretary of New South Wales—R. C. Critchett Walker, Esq.—for many services and courtesies. The reports and papers supplied by that gentleman were of the greatest value. One, a report of a Select Committee appointed by the New South Wales Legislature to inquire into and report upon orange-culture, furnishes information on every conceivable point. Another, the report of Charles Moore, Esq., Director of the Sydney Botanic Gardens, who was sent to Spain and Portugal by the Government to inquire into and report upon the same subject, was no less valuable. The gist of these inquiries is embodied in this work.

The writer personally visited the orangeries at Parramatta, and spent some considerable time there with Mr. James Pye, a gentleman who has been cultivating the orange for upwards of seventy-five years, and than whom, the Director of the Sydney Botanic Gardens informed the writer, there was no better authority upon the subject in

the sister colony. This explanation is necessary, as the name of Mr. Pye will be found mentioned somewhat often in the following pages.

The author is not without practical experience on this subject, having been engaged cultivating the orange and lemon at Whangarei for some years past. Though that experience does not extend over a sufficiently long period to establish the writer, of itself, as an authority upon orange-culture, it nevertheless has fitted him to prepare a handbook that will be found to contain every information required even by the veriest noviee. The writer has availed himself of the works on orange-culture written by the Rev. T. W. Moore and George W. Davis, both of Florida, United States. The former work is recommended by the State Bureau of Immigration, Washington.

The writer experienced great difficulty in dealing with the subject of insects through there being no work obtainable on New Zealand entomology; and it is to be hoped that some steps will be taken to remedy this great want, particularly as insects injurious to the fruit industry are increasing with alarming rapidity, and none more so than the destructive "scale." Mr. W. M. Maskell, Registrar of the New Zealand University, F.R.M.S., is the only authority in New Zealand on scale insects.

This handbook will amply demonstrate that the cultivation of the orange will, with suitable land and location, combined with intelligence, application, patience, and skill, prove more profitable than any other known industry. The Rev. T. W. Moore, in his work before alluded to, remarks: "When compared to the profit from other kinds of business, that derived from orange-growing is so large that a statement of facts is often withheld, *because the truth seems fabulous* to those who have only had experience with other kinds of fruits." Any one acquainted with the industry will know that that is no high-falutin, but a positive fact. When the profit is not so excessively large it is the fault of the planter, and not of the industry.

Suitable "soil and location" is the secret, and, without these, orange-culture is nowhere.

Moore, in speaking of the amount of suitable land in Florida, which is pre-eminently an orange-growing country, says that not one-hundredth portion of the land of the State is adapted to the purpose. In northern New Zealand, probably not so large a proportion is suitable; but good sites will be found along the East Coast from the Town of Napier to the North Cape. There is no place in the colony where the orange could grow better than at the Town of Napier, providing the trees were irrigated in summer. Napier has the driest and hottest climate in the North Island. The best land, however, everything considered, will be found contiguous to the coast from the North Shore, Auckland, to Mangonui; and the best sites will probably be found between Whangarei Heads and Cape Brett.

The picture at the front of this book will show how the orange-tree grows in North Auckland. Sir George Grey informs me that his trees at Kawau are not so large as this one, and as many as three thousand oranges have been taken from a single tree there.

Persons about to embark in this industry should, if possible, locate themselves near to others who are cultivating the orange, so as to avail themselves of the advice of those who have practical experience; and this point they should always bear in mind: that a really suitable site is comparatively priceless. In California, as much as £50 an acre is given for wild land suitable for orange-culture.

The writer will be happy to afford any further information in his power to persons who may solicit it.

Whangarei, 30th October, 1884.

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ORANGE-CULTURE.

1. FROM an intimate knowledge of the North Auckland District, with some years' practical experience of orange-culture, a very exhaustive research into works on the subject, and a personal inspection of the orange-growing districts of New South Wales, I am convinced that oranges can be grown as well in North Auckland as in the far-famed Parramatta District. The North Auckland climate is, in a manner, more equable—*i.e.*, neither subject to drought nor to excessive rainy winters, either of which is very injurious and often destructive of the orange-tree, and both of which occur periodically at Parramatta. It is probably not generally known that between the years 1860 and 1870 hundreds of acres of orange-trees were destroyed on the Parramatta through, says the report of the Select Committee that was appointed to inquire into and report upon the loss, "unusual climatic influence, induced or accompanied by excessive rainy seasons, the earth thereby becoming too cold and wet to support the orange-tree in perfection; and, second, to defective cultivation." Mr. J. Devlin stated before the Committee, as an instance, that his orangery, from which he had received as much as £1,000 to £1,200 a year, had been totally destroyed. Many others gave similar evidence, and described the disease as what is known in Portugal (where it first appeared) as "lagrima"—the rotting of the bark at and below the collar of the tree—a disease induced by fermentation of the sap. Irrespective of this evidence, I found many of the trees at Rocky Hall, the estate of Mr. James Pye, tinged with yellow—a sure sign of something serious being wrong—and, upon inquiry, was informed it was the effect of the drought of 1883–84. I have never seen orange- or lemon-trees in North Auckland looking so bad, excepting they were riddled by "borers," an enemy, by the way, that the Australians know little of. Further, I can state unequivocally that trees in North Auckland are, taken as a whole, healthier-looking than those to be seen at Parramatta. By these reasons I am led to the conviction that situations are to be found in North Auckland which are admirably suited to the growth of the orange. I would have my readers to observe that I say

"sites are to be found," by which I do not mean to imply that oranges will grow successfully anywhere in the North. The success will depend more upon the site than anything else. And I would observe, parenthetically, for the benefit of those persons who have a bad habit of conceiving a prejudice for local products generally, it must be borne in mind that so far nothing but the seedling stock of orange has come into mature bearing up north, the sweet grafted stock of orange only having recently been planted. I am led to make this remark because it is a popular idea that we can grow nothing but a sour orange in the North. That idea is wholly attributable to the fact of the "seedlings" which are now bearing being of an indifferent quality of stock, and probably, too, to being unsuitable to the district. For it is a well-known fact that locality has as much to do with the quality of the orange as with the grape.

2. As to the profit of orange-growing. The view of the matter in Australia is put this way: Given a suitable site and other circumstances favourable, the crop will pay *four* times better than anything else you can grow. It is no use going into figures; they at the best would be purely imaginary, as different circumstances would govern every case. No doubt fortunes are to be made, and have been made, from orange-growing, but that does not necessarily imply that all orange-cultivation must pay. As a matter of fact, very many persons have tried to grow oranges and failed most egregiously. Mr. Pye informed me that trees of mature growth—that is, say, at ten years of age for grafted trees—will not average less than one hundred dozen oranges per year, the lowest average price given for a crop being 6d. per dozen, so that each tree should average £2 10s. a year. With seventy trees to the acre, the annual value of the crop would be £175 per acre. As a matter of fact, this is a low estimate for an orangery situated on suitable land, and in a suitable position, as some trees bear as much as three hundred and fifty dozen oranges. The immense profits made out of orange-growing may be seen when I state that at Parramatta, as elsewhere, the general system of cultivation is such that one man can attend to ten acres, and the only manure used as a general rule and by the best planters is leaf mould from the forest or well-rotted stable manure. From this it will be seen that ten acres will bring in £1,750, against which you have to place the wages of one man, the cost of carting leaf mould or other manure, and a small sum for implements and insecticides. Any one who cares to inquire, however, carefully into this subject will find that the trees, if well situated, will yield more on an average than the figures above

given. There is a tree now at Mr. E. Dent's, on the Bay of Islands Road, Whangarei, from which not less than one hundred and fifty to two hundred dozen of fruit are gathered annually. At Waimate and Mangonui as much as seven pounds' worth of fruit has been taken from a single tree. These trees are seedlings, and about twenty years old.

3. The circumstances that are required for successful orange-cultivation are somewhat numerous, and seldom obtained without artificial aid. People must not jump to the conclusion that oranges will do anywhere; because such is not the case. True, orange-trees may be made to grow almost anywhere, but only in special places can they be grown successfully and with profit. Too often a man will be found who, seeing his neighbour succeeding with, say, oranges, thinks he can do the same, although the circumstances under which he tries are entirely different. When that man fails, he does not blame his own stupidity, but becomes a stubborn opponent under all circumstances of that particular plant. I want, if possible, to check that sort of thing, and I do not want people to think, because I state that fortunes are to be made at orange-growing, that they can all go straight in for a rosy competence; because they cannot do anything of the sort. I need only remark that, if fortunes were so easily made at this industry, as many people would be found growing oranges as cultivate the staple crops, such as oats, potatoes, &c. Even in orange-growing countries, the suitable land is limited, and hence we find a settler owning land adjoining an orange grove unable himself to cultivate the fruit with any large degree of profit. Without a suitable location you might just as well try to grow tomatoes by the aid of the moon as oranges profitably. What is wanted is this: a sheltered site with natural drainage and a light porous soil. I take this description from Mr. Pye's estate. It is situated in a nearly perfect basin, the rim of which is surrounded by a belt of gum-trees. It is thus sheltered from every wind, and to a considerable extent from the morning sun—the latter being a very important desideratum, in that the trees when frosted in winter and exposed to the morning sun are liable to burst their cellular tissue through the too sudden thawing of the frozen sap. The formation of the land on this estate consists of a number of stratified sandstone shelves or natural terraces, some lying nearly flat, others sloping towards the creek which zigzags the estate, but all are situated so as to have drainage from natural formation. The only drainage Mr. Pye had to provide for was that of the surface. The soil appears to be pure sand, and in some places there is not more than 9in. of that; but the trees do very well

on it, with the aid derived from the dressing of leaf mould before alluded to. The best soil, however, is sandy loam; and in one little nook, where there is a depth of about 9ft. of this on the bank of the creek, Mr. Pye has four trees growing, the highest of which measures 37ft., and they are eighty years old.

4. Sites most suitable for orange-trees are often useless for any other purpose, being broken and unworkable with the plough. The bulk of Mr. Pye's celebrated orangery is of this class. A site such as this is not easily to be found, unless you go back into the interior away from the highways. Artificial aids must be called in, such as shelter and drainage. Where these have to be provided the profits are not likely to be nearly so large, as the capital to be invested will be to that extent increased, and the period of returns will be delayed through having to wait for artificial shelter to grow. Obviously a naturally-drained and a naturally-sheltered situation is worth infinitely more than one that has to be artificially prepared.

5. As to soil, in Australia a sandy loam is considered the best, and heavy clay the worst. In the Azores—where some of the finest oranges in the world are produced—the soil is volcanic, and similar to that of North Auckland. Without a doubt, nothing could be more suitable than our rich bush volcanic soils—that is, where the subsoil is not clay, for when the roots rest on clay they are liable to contract foot-rot or lagrima (see remarks elsewhere). Of course, if the subsoil is naturally drained (or, for the matter of that, artificially), this argument does not apply. Orange-trees grow in clay land, and in some cases do very well; but nevertheless it is the worst land for oranges, in that it is the most retentive of water, very liable to crack on the surface in summer, and does not permit of that free circulation of the air which is so essential to the nourishment of the fibre roots of the orange-tree which grow just below the soil. In addition to this, it is held that clay land, being cold and wet, produces sour fruit: the lighter the soil the sweeter the fruit. An instance is quoted in Australia of a gentleman trenching land with a clay subsoil to a depth of 20 inches at a cost of £40 an acre, whose orange-trees in a few years' time, after bearing prolifically with the aid of manures, died completely out. I refer to Mr. Justice Holroyd, who, in a letter to me on the subject, says that, after spending £500 in trying to resuscitate his trees, he had to relinquish them to the ravages of the scale. Mr. Pye does not approve of a clay subsoil: in fact, he considers it fatal to successful orange-growing. No matter what the soil is, if water finds a lodgment about the roots of the trees, the roots will rot, and it can be easily understood that clay land would be the most liable

to cause this disease. It might be borne in mind, nevertheless, that where there is natural drainage (on the bank of a creek, for instance), to a depth of 8ft. or 10ft., clay land would answer, though not as well as a lighter soil. The land best suited to the growth of the orange in the North is the deep volcanic land which has natural drainage. Of course it would never pay to drain 8ft. or 10ft. deep, and so sites are always selected that have natural drainage. Hillsides or spurs are usually naturally drained to a great depth, and even some nearly level volcanic land has a deep natural drainage; and the way to test it is to dig a hole 10ft. deep, and, if no water springs into it in twenty-four hours' time, it shows that the land has a natural drainage to that extent. But the land on the surface should not be too flat, as the surface water wants to be carried off quickly, and in Australia very steep hillsides are often used for orange groves, so that both surface and deep drainage are secured. Whatever land is selected for orange-culture must have complete drainage, and for this reason land naturally drained is invariably used. If there be any lodgment of water at the roots of the tree—even if only a single little root be affected—fermentation sets in, and, as there is no mode of seeing that root or of cutting it out, the fermentation extends slowly upwards. As soon as it comes within range of the sun's rays, the disease breaks through the bark of the tree just below the surface, and, if not then skilfully treated, the tree dies. We see the same thing above ground in what is known as the "die-back"—that is, the dying of limbs. That also is caused by the fermentation of the sap, and, unless the "fermented" limb be cut off, the fermentation goes on and the limb continues to die. The want of proper drainage causes precisely the same effect below the ground, but we cannot see the diseased limb, nor are we able to cut it off. The importance of drainage must be obvious.

6. Many people have told me that their trees have lived for a number of years, and then gone off with foot-rot. That is easily accounted for. So long as the roots of the trees were in the ground that was drained (either naturally or artificially), the tree was all right, but, as soon as the roots began to penetrate the undrained soil, then the disease set in. Though hundreds of acres of trees were lost in New South Wales between 1860 and 1870 from this disease, but few trees are now lost from it, as the treatment of the disease is understood. The chief cause of this disease in New South Wales was held to be the system of planting—namely, the planting of the young trees in holes. These holes naturally act as so many cups for the water, and during heavy summer thunderstorms

the water cannot get away quickly enough. Before, indeed, it has time to get away, the fierce Australian sun heats it to an extent that must be injurious to the bark of the tree. Now they plant their trees just the reverse way—shallowest under the tree and deeper away from it: that is to say, the tree would be planted, as it were, on the top of an inverted saucer, and the ground would be dug deeper and deeper towards the surface drain between the trees, so that all water that fell to the foot of the tree would immediately run down the sides of the saucer to the surface drain.

COST OF ORANGERY, AND PROFIT.

7. The first point a man requires to be convinced of before going into an industry is: Will it pay? Now, there is no doubt that a good deal of high-falutin has appeared in the Press regarding the profits of orange-growing. Articles on such subjects are often penned by enthusiasts, who, having heard most likely of an exceptional yield, and being astounded at the result, at once conceived it to be their duty to publish the information to the world. If such writers had any practical knowledge of the subject they were writing about, they would be careful to strike the average instead of giving the maximum results. But such writers seldom have any such practical knowledge: they are, maybe, paid to write on every conceivable subject, and the wonder is that they do not commit greater blunders. I have now before me *Chambers's Journal* for November last, in which appears an article advocating orange-farming in North Auckland. This is an article in point, which, while alluding to exceptional yields, leaves its readers to infer that such things are common. Speaking of the profits of the industry, the writer says,—

It is mainly towards the New World that the intending planter and immigrant should look for gratifying financial results connected with orange- and lemon-raising. Certainly, it is in California that this industry at present shows statistics more extraordinary and encouraging than almost anywhere else. There, we are informed, an average tree yields, at the age of ten to twelve years, a thousand oranges; that forty oranges may be seen hanging from a single bough, which must be supported, to hinder it from breaking under the fragrant weight; that individual trees yield two thousand oranges, and one distinguished specimen three thousand oranges, per annum; that one man is capable of looking after a plantation of twenty acres: and that a fruiting orchard of ten acres is expected to return an annual profit of £2,000. Pleasing reading as the above may possibly be to the intending farmer, even those cheerful figures are transcended as one gets nearer to New Zealand. In New South Wales there are certain orange plantations the annual gross return from which is given as £500 per acre; and single trees are pointed out to the

inquiring traveller which, for more than twenty years, have rewarded the proprietor with each three hundred dozen of the finest fruit per annum.

8. Now, that is not stating the case fairly. The writer evidently wanted to give an interest to his article, and for that purpose has drawn rather a long bow. True, the average yield of an orangery in California is put down at one thousand oranges to each tree, there being one hundred trees to the acre, which gives one hundred thousand oranges to the acre; but, granting the average is a fair one, the statement is incomplete without the fuller explanation of such average applying to a suitable soil and situation. The statement, too, that one man could look after twenty acres is very misleading. Where the ground is quite level, and the trees planted in regular order, a man would be able to keep the weeds down with a team of horses and a plough or scarifier; but, to do all the work required in an orangery of that size, a good deal more labour would be necessary, particularly on our volcanic soils, on which weeds grow with amazing rapidity. The loamy lands of New South Wales are not nearly so bad for this. My own experience, and that of my neighbours, has been that it takes one man all his time to fight the sorrel in spring-time on a much smaller area than ten acres. Where, too, the orangery is on a hillside, or where the plough cannot be used, one man could not in this colony look after more than five acres properly. Besides keeping down the weeds, he would have to chip or dig the ground, and get the mulch or manure on to the ground, &c.

9. As to there being plantations in New South Wales that gross £500 per acre, that is purely chimerical. Oranges there are sold wholesale at 6d. per dozen, and an acre to return £500 would have to yield 240,000 oranges, or 2,400 each tree. The other statement that single trees bear three hundred dozen a year, though not absolutely incorrect, is put in a misleading way. There are four trees at Parramatta, belonging to Mr. J. Pye, which are eighty years old, and these have borne as much as three hundred to three hundred and fifty dozen in a year; but they are exceptional trees. Persons are apt, when enlarging upon their own virtues, not to err on the side of modesty. At Parramatta I was told that these identical trees were the largest in the world; but Resso, in his "Natural History of the Orange," mentions that at Nice there is a tree over 50ft. high; and Senator Jose de Canto, in a communication to the Director of the Sydney Botanic Gardens, speaks of trees in the Azores, from two to three hundred years old, producing from 6,000 to 20,000 oranges a

year. The four big trees at Parramatta are but 37ft. high, and only bear in the best seasons about 5,000 oranges.

10. Below is a statement of the cost and produce of an orangery by Mr. L. M. Holt, Secretary of the Southern Californian Horticultural Society. This estimate is given in Moore's work on "Orange Culture," and, as the book is recommended by the State Bureau of Immigration, Washington, I do not think any better data are to be obtained so far as the industry as pursued in the United States is concerned. Mr. Holt is an authority upon the subject, and, as the statement was only made to the Society in 1883, it may be accepted as fresh :—

An orange orchard in full bearing will yield a hundred thousand oranges to the acre. Five dollars per thousand will pay all the expenses of taking care of the orchard, and picking and marketing the crop in San Francisco, or any other market to which the freights are no greater. If the price should come down from the present figure to $10 per 1,000—jobbing rates—there will still be left $5 per 1,000, or $500 per acre for the producer, which on a 10-acre tract will satisfy the cupidity of the most avaricious. There is scarcely a possibility that the price of good clean oranges will reach so low a figure as $10 per 1,000 yet, for years to come.

WHAT WILL IT COST TO GET SUCH AN ORCHARD?

As a guide to those who may desire to figure on the probable expense of starting an orange orchard, I give below some figures which are applicable to Riverside: they must be changed somewhat for other localities. Land in Riverside settlement is comparatively high. One year ago good wild land could be obtained for $75 per acre, and even at $60 per acre under the canals. To-day there is none for sale at a less figure than $150 per acre, and choice land in good locations is held at $200 per acre firm. Lower-priced lands can be had in other localities, and in no place n Southern California does it command as high a figure as here in Riverside. In applying these figures to other localities the price of land can be figured all the way from $25 to $100 per acre. Following are the figures for a 10-acre tract :—

	$
Ten acres of land in Riverside	1,500
One thousand trees, budded or seedling	750
Planting and caring for same, first season, at $25 per acre	250
Caring for orchard, second year, at $15 per acre ..	150
Third year, $15 per acre	150
Fourth year, $20 per acre	200
Fifth year, $25 per acre	250
Other expenses incidental to work	550
Total for five years	3,800
Interest on investment	1,200
Total	$5,000

This is the expense account. There will be some receipts. If good budded trees are planted, the third year will give a little fruit, the fourth year still more, and at the end of the fifth year there will be quite a fine

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crop. In order to be safe in these calculations we will place the yield and prices at the lowest possible estimate :—

Third-year crop, scattering oranges—a few hundred or thousand—not counted.	
Fourth year, an average of fifty oranges to the tree—50,000 oranges at $20 per thousand	$ 1,000
Fifth year, 200 to the tree—200,000 oranges at $20 per thousand	4,000
	$5,000

If these prices are maintained the owner has his investment all back again at the end of five years, and is ready to ship oranges in large quantities every year thereafter.

All persons planting orange orchards do not do as well as this, and some do better. Those figures represent what can be done with good judgment and thorough work. If a man thinks to save by getting cheap and incompetent work, he may succeed in reducing the cost a few dollars, and the receipts a few hundred dollars, or even a few thousand dollars. If he buys a poor tree he can get it for twenty cents, instead of paying the market price for a good thrifty tree; he will make another saving in cost of orchard, and in cost of boxes in which to ship the fruit.

11. In looking into this calculation carefully, the reader will be struck with two or three apparent errors. In the first place, the land is classed as "wild," and only $25 an acre is allowed for breaking up the land and planting the trees and keeping it in order for the year. Nothing can possibly be left for drainage, so that we must take it for granted that the site selected is naturally drained. Nothing either can be provided in the calculation for trenching the ground, and we must further take it for granted that the estimate is for the system known as "shallow cultivation." That is the system I approve of, and my reasons will be given hereafter. Briefly, it requires the least capital, and returns the largest percentage of profit on money invested. By this system the ground is in the first instance ploughed deeply, and the trees planted in rows 22ft. apart, quincunx (giving 100 to the acre). The after-cultivation consists of ploughing three inches deep about the trees, and deeper away from them. If mulching cannot be obtained, ploughing has to be repeated often enough to keep the ground clean and free from weeds, and, where ploughing cannot be done, the ground must be chipped by manual labour. Mulching is the cheapest method of cultivation, as it is equivalent to manure and frequent working of the soil; it also secures sufficient moisture for the roots of the orange, and gives fertility to the soil. Under such a system, it will be seen that $25 an acre would do the work, so long as the plough could be used. But it must also be taken into consideration that these figures are based on the assumption that the planter is a farmer, and owns his own team of horses, &c.; otherwise he

could not do the work for the money, nor would there be any means of constant supervision of the property. $250 a year would not keep a man and a team of horses in this country, and a larger area than ten acres would have to be cultivated to bring the expenses within this minimum, because a skilled man would have to be constantly on the ground, and there would always be plenty for him and a team of horses to do, either in ploughing or drawing mulch. The price of land and cost of orange-trees is higher in the above calculation than would rule here.

12. The following estimate would be nearer the mark for this district:—

Ten acres suitable land	£100
1,000 grafted trees	50
Planting and caring for orchard, first to fourth year, one man at £100	400
Cost of team of horses, plough, and dray, &c. ...	200
	£750

13. Leaving out the question of interest, we will come to the produce. The estimate of results seems to be a fair one. From that calculation it will be seen that the fourth year the orchard would produce 50,000 oranges, which, at 9d. per dozen, would be worth £152 12s., and that amount would more than pay the expenses of the fourth year and leave a small surplus. The fifth year the crop would be 200,000 oranges, worth £610 8s.; and the sixth year the orangery would have paid its whole cost, besides leaving a large balance for the proprietor.

14. In from ten to twelve years' time the orangery would be in full bearing—that is, producing 100,000 oranges per acre, which, at only 6d. per dozen, would return for ten acres £2,086, or much more every year than the whole affair had cost. If a larger area were worked, and the land were ploughable, the expenses would be proportionately decreased, as one team of horses would do the work of twenty-five acres and two teams that of fifty acres; and by planting peach-trees between the orange-trees until the latter wanted the ground some little revenue might be obtained the third and fourth years without any further expense being incurred. The ground between the rows, too, if not mulched, might during the first years be made to produce something that would at least pay for the working, if not return a profit. This system of cropping is not recommended, but, when the planter cannot afford to wait till the trees begin to bear, some little assistance may be obtained this way. Now, in regard to these figures, the fact must not be over-

looked that, to obtain the results described, all the requirements for successful orange-culture must be present. For the few people who have really made a success of the industry in Australia, hundreds have failed either in part or totally: some from want of skill, some from want of perseverance, some from want of suitable soil and location. Orange-culture is undoubtedly immensely profitable under favourable circumstances, where the soil, drainage, and shelter are perfect; but such sites are only here and there found, and were it otherwise everybody would launch out orange-growing and thereby spoil the industry by glutting the markets.

15. Another matter will be noticeable in the above estimate, and that is that nothing is allowed for manure. Persons in North Auckland had got hold of the erroneous idea that orange-trees must have any amount of manure. Admittedly, there is amongst old planters a difference of opinion as to how much manure the trees should have, but the most experienced and oldest planters affirm that a too liberal use of strong manure tends to deteriorate the quality of the fruit. Mr. Pye informed me that he had tried every system and every kind of manure, and was now convinced that trees should never be manured with anything but mulch, unless they showed signs of weakness. If the tree were forced the fruit would not be so good: it would be tart and acid in place of being sweet and juicy. Speaking of the use of manures, Mr. R. E. McIntosh said that the scale and other diseases were never known in New South Wales until bonedust and guano were used. In his evidence before the Committee already mentioned, he said: "Wherever bonedust, guano, or boiling-down manure is used, I have invariably seen it the case that when the trees should be yielding the most they are dying out." More of this anon.

16. There is, of course, always the off-chance of the industry being overdone, and the supply being far in excess of the demand. But that probability is very small, and for the reason that so few really suitable sites are to be obtained. In New South Wales the orange only succeeds in a very small portion of the colony, namely, at Parramatta, Windsor, Campbelltown, Penrith, and Maitland; the produce of these places in 1882–83 being,—

Parramatta	3,169,808	dozen oranges
Campbelltown	36,000	,,
Penrith...	100,000	,,
Windsor	600,000	,,
Maitland	54,000	,,
Total	3,959,808	,,

Of that produce New South Wales sends a very large quantity to New Zealand. The sister-colony sends to New Zealand yearly about sixty-seven thousand cases of fruit, valued at £28,000, so that we have here a market for a large quantity of oranges; a demand to supply which we should have to plant as large an area in oranges as that planted at Parramatta. In addition to what we receive from New South Wales, we also take from Fiji and the South Sea Islands twenty-four thousand cases of fruit, mostly oranges, annually. There need be no fear as to overdoing the industry, as, by the time the trees come into bearing, the population of the colony will have increased considerably, and we could always be exporters, as the crop here would be nearly two months later than that of New South Wales. This season (1884) the crop has been a failure both in New South Wales and in the Islands, while here the crop, if anything, is larger than usual; and this goes to prove that our climate, being more equable, is more suited to the growth of the orange than that of the sister-colony. In addition, too, to the sale of green fruit, there is a good market for marmalade, candied peel, &c., New Zealand importing jams, jellies, and dried fruits annually to the value of £30,000, which, added to the cost of imported green fruits of £83,000, show a trade worth £113,000.

17. There is one other matter which ought not to be lost sight of in considering the profits of orange-growing, and that is this: that the leaves, tender shoots, flowers, young fruit dropped, and sour fruit are all marketable, or at least will be in a few years' time, for the manufacture of oils, perfumes, extracts, &c. In Europe the manufacture of these products is considered equal in value to the fruit exported. Essential oil is made from the tender shoots and leaves; the most delicate oils and perfumes are made from the flowers; citric acid and concentrated lemon-juice from the lemon. The sale of these in Europe is reckoned to pay for the cultivation of the grove, but they are not so far advanced as this in Australia yet.

THE PHYSIOLOGY OF THE ORANGE-TREE.

18. To thoroughly understand the why and the wherefore of the special treatment of the Citrus tribe, it is absolutely necessary that the planter should possess at least an elementary knowledge of plant-life. But to many such a statement will appear as mere affectation. Lots of persons have orchards, and grow fruit successfully, and, say they, "If we can grow a peach or an apple or a plum, why can't we grow an orange? Hang science and scientific terms—we are practical, and have

discovered the proof of the pudding in the eating." And others say, "Oh, orange cultivation is going to be overdone—everybody's going in for it." To the latter, it is only necessary to say that in New South Wales there are 7,200 acres in oranges, and this season the crop has been sold at 1s. per dozen; in New Zealand there is not the two hundred acres, let alone the seven thousand acres, nor, for the matter of that, thirty acres.

19. And to the former it might be answered that for the one man that succeeds at orange-cultivation a host fail, because the popular idea is that "anybody knows how to grow oranges." The man, however, who really desires to know how to grow the orange must observe the growth of the plant methodically and accurately, and have the "nous" to be able to apply that knowledge skilfully. He must understand thoroughly the relations of the plant to the air and soil, the use of the leaves and the roots, and the habits of the latter; how the tree is nourished and what plant-food it requires; the effect of moisture, heat, and light. All these matters and many more pertain to vegetable physiology, but just these are all that are necessary for the planter to grapple.

20. Firstly, then, it may be broadly stated that the orange-tree resembles in some respects a human being: it has a skin, called the epidermis, which is studded with breathing pores, called stomates, which open more widely in the light than in the dark. As a man enjoys the best health and spirits in the sunlight, so the orange-tree; and if it be grown in a dark corner it will be like your man of the dark hovel—very little good for anything. And what purpose do the leaves serve? Physiology demonstrates to us that they are so placed as to receive as much light as possible on the surface, to absorb the carbonic acid of the air, and to do other things which will be referred to further on. Physiology here demonstrates that unless the leaves are exposed as much as possible to the light they serve no purpose. If, for instance, the interior of the tree is a dense mass of leaves, entirely shut out from the light by the outer foliage, then such leaves were better cut off; or, in other words, the tree should be pruned to permit of a more profitable elaboration of the sap and the freer circulation of the air.

21. When the interior of the tree is filled up with useless twigs and leaves—such as is the case with most old "seedlings" that have never been pruned—the vitality of the tree is checked by a waste, in this manner, of the sap, and the air from which the pores breathe life is excluded and not permitted to circulate. The tree should have an open head, that

is, only such leaves being allowed to remain on the tree, broadly speaking, as can show a clean front to the light, the interior or shaded part of the tree being open to the air—the only thing that can do any good there. Like a man, too, the orange-tree must have a clean skin to be healthy and vigorous. Experience has proved in Australia, as elsewhere, that the use of greasy compounds for insecticides is very injurious. If a man were coated over with cart-grease or some other sticky compound, the pores of the skins would be choked, and he would suffer disease: so it is with the orange-tree when soft soap and such-like things are used too liberally, to kill the scale: the stomates become bunged up. The effect is the same in both cases. A single apple-leaf has a hundred thousand of these breathing-pores, by which the process of transpiration is performed: that is, the sap of the tree, on becoming exposed to light on the surface of the leaf, parts with a great deal of its water as vapour. This keeps the plant cool in the hottest weather, and when stopped the effect can be easily imagined—the circulation impaired, the blood weakened, and hence a predisposition to decay.

22. A dirty man is very likely to be troubled with vermin: so an orange-tree when dirty, from whatever cause, is likely to be attacked with scale, the very appearance of which is very similar to lice. Mr. Pye is so particular on this point that he makes his men brush the scale off the trees with a hard brush or piece of coarse sacking, after which he uses Gishurst's compound on the tree, which, in place of having an injurious effect, is very beneficial. The tree, to be healthy and vigorous, must have a clean skin just like a human being. It breathes and lives the same, and its protoplasm would die were respiration stopped—that is, the getting rid of superfluous carbon. Trees are not only nourished by their leaves, but by their roots. The latter absorb water in which both gaseous and mineral matters are dissolved, and this fluid or sap ascends into the leaves, which take in carbonic-acid gas from the air. The part light now plays on the leaves is this: It forms the water and carbonic acid in the leaves into starch, and that is distributed throughout the plant, supplying material for adding to its parts.

23. A very important matter to be observed is this: that the sap of a tree is not merely particles without definite form or structure, but consists of minute bags and tubes packed closely together. The tree contains, stowed away in these little cells, a far greater weight of water than anything else, and is in consequence very susceptible to frost and very liable to suffer severe injury. When water freezes it expands: so with the sap of the orange-tree. The sap by thus expanding

ruptures these minute bags and tubes, called the cellular tissue, and the oxygen of the air penetrates these ruptures, and, combining with the sap, causes fermentation.

24. And this fermentation, if unchecked, will not only affect a single limb, but the whole constitution of the tree, and likely kill it. Some people suppose that only the limb will be affected; but that is fallacious, for, as Mr. Pye says, "If I take a disease, it must commence in some place, but it affects the whole body." The effect of the direct rays of the sun suddenly thawing a frosted tree is to contract the bark and enlarge the avenues for the atmosphere, causing the cold to be more fatal in effect. But the fact of fermentation being the cause of frosted limbs dying should be borne in mind, as it will be observed that, unless the fermented portion be cut out, it will soon affect the whole system of the tree.

25. It is equally important that the limb, when cut, should be in some way protected at the wounded point from the effects of the atmosphere. When a limb is cut the cellular system is exposed, and must be covered, as, when a man's leg is cut off, if the arteries were not tied up the man would bleed to death. The sap forming the interior of the limb has the appearance to the naked eye of being a solid substance, but when inspected with the aid of a microscope it will be seen to consist of numerous little cells, and, to prevent the atmosphere from penetrating these, it is necessary that the wound be covered with something—with whitewash, for instance—so that the cells are bunged up.

26. A thorough comprehension of the functions and habits of the roots of the orange-tree is indispensable. Primarily, roots are divided into two classes, main roots and fibres; the former acting as supports or buttresses to the tree, while the latter gather up from the soil particles of food in a liquid state by means of the small absorbent radicles. The larger roots do not absorb moisture; hence it is very necessary that when orange-trees are to be transplanted they should have as many as possible of the small fibrous roots preserved, otherwise the flow of sap will be checked and the growth of the plant injured.

27. No other tree has such a mass of fibrous roots as the orange-tree. These roots absorb liquid food, the principal components of which are nitrogen, phosphorus, potash, sulphur, and iron. In the case of the orange-tree, it will be observed, the fibre roots grow very near the surface—in fact, have a tendency to come actually to the surface. Now, what is the cause of this? So far, I have never known any writer to offer an explanation of this habit of the orange-tree, but a

gentleman in Australia thought it was owing to inadaptable cultivation, and to overcome the matter he trenched his ground 20in. deep, with a view of encouraging the roots to sink lower. He did just what he ought not to have done. The habit of the root is to grow near the surface, and if it were induced to sink lower down by high cultivation—which it undoubtedly would do where the ground was trenched—it would suffer in the long-run by the subsequent consolidation of the ground excluding the air. It is the nature of the tree to be a surface feeder, and if these roots are covered too deeply they become smothered, and the tree likely dies. Those roots come up to the surface for two reasons.

28. The first no doubt is because there is, as a general rule, about twenty times as much fertility or organic matter in the first nine inches of soil as there is in the subsoil; and, secondly, because the roots are in search of air, from which they, like the leaves, breathe in carbonic acid, and hence it is necessary that the soil of an orangery should always be kept free from weeds, and open to permit of the most abundant circulation of air, which not only supplies carbonic acid to the roots, but is pre-eminently itself the best of all fertilizers, in that it with the aid of moisture induces *nitrification* in the soil—that is, the dissolving of insoluble plant-food which exists in the soil, so that the plant can utilize it.

29. The mulching of the ground with suitable material answers the same purpose. It keeps the surface moist, and thereby attracts the roots to the surface, while *suitable* mulch supplies the requisite amount of organic matter for the food of the tree. What is the requisite amount of organic matter appears to be the stumbling-block over which all planters disagree. And in Australia they years ago hit upon the very crude method of supplying the trees annually with *fresh soil*, which answered from a manurial point of view, but eventually caused much injury.

30. Looking at the matter superficially, one would naturally come to the conclusion that a tree which yields such heavy crops, and has such an immense root system, would require a proportionately large amount of manure, or a soil rich in vegetable matter. But what are the facts in connection with orange-cultivation? An official paper before me states that, "In the Azores, before the lagrima appeared the *orange-trees wanted no culture at all.* The old trees produced abundant crops of the most beautiful thin-skinned fruit, well ripened by exposure to the sun and a free circulation of the air." That statement is authentic, and not a mere theory. In a communication at the end of this book, on orange-growing

in Fiji, it is further shown that the orange does not want manure.

31. In Australia, Mr. Pye, the oldest orange-planter, finds that a suitable soil, well taken care of and kept free from weeds, is all that is needed, and says further that artificial stimulants only spoil the fruit. And one thing is very certain, that there can be very little organic matter in his light sandy soil; the mulch of forest leaves he uses supplying the sole vegetable matter for his fine trees. In another place it will be seen, by the analysis made of his soil by Mr. Skey, of the Wellington Museum, that it consists of nearly pure sand. Nevertheless, I feel that most people will persist that they know better, and will go on using strong manures, to the great detriment of the industry.

32. Any one who will study the matter closely will find that the orange-tree succeeds best not so much from any inherent fertility of the soil as from an abundance of moisture and heat: in fact, it lives on the heated humidity of the atmosphere. Its root system proves this beyond doubt, for the fibre roots are in the case of a healthy tree invariably just below the soil, and where such is not the case the tree is not vigorous, and in time dies. This is again proved in the deep setting of an orange-tree. If the lateral or fibre roots are buried so deep that they cannot communicate with the air, the tree slowly dies. The roots by being near the surface are not only able to absorb carbonic acid from the atmosphere, but take the fullest advantage of the fertility of the soil, there being, as before stated, about twenty times as much nitrogen, phosphoric acid, potash, &c., in the first nine inches of soil as there is in the subsoil.

33. I have dwelt particularly on the habits and functions of the roots with a view to planters knowing how they ought to be treated, and so that they may not fall into the same error as I did in one instance—a very stupid error as it now appears, and one that ought not to have been committed by a man of ordinary sense; but, as there may be other over-zealous amateurs like myself in the world, the best method of killing a tree may as well be known. I had a beautiful healthy three-year-old tree, and it had about a dozen oranges on it. I was desirous of forcing the tree, to see what could be done. Naturally I said, "Now, as that tree is bearing, it must be fed," and I at once applied six inches of earth that was saturated with blood. In about six weeks' time the leaves began to turn yellow—got the "yellow-jack," as I call it—indicating that something had gone wrong, and then the scale attacked the tree badly. I thought the whole trouble was attributable to

the scale. Never thought of anything else, and completely "douched" the tree with a strong solution of soft-soap and water. Now, what had I done through sheer ignorance? In the first place I had, by the coating of earth used, *smothered* the fibre roots. The air had been shut out, nitrification was stopped, the roots could obtain no nitrogen, and the leaves turned yellow for the want of it. Then, to improve matters, I clogged up the pores of the leaves by the too free use of greasy soft-soap. Now, if I rammed a man's mouth and nostrils full of earth, and spread him over with a coating of dissolved gutta percha, he wouldn't live long. But that's just what I did, in effect, with that tree. I murdered it out of sheer kindness and rank stupidity.

34. I do not suppose other people will be so silly as I was, but I never knew how silly I had been until I went to Australia, though I had been cultivating oranges for years, and made a hobby of studying the industry and of reading every available work on the subject. I had read that soft-soap was the best remedy for the scale, and that the tree was a ravenous feeder and could not be given too much manure. I gave it soft-soap and I gave it manure; but the same quantity divided among twenty trees might have been beneficial, while given to one it was just the reverse. Practical experience, however, demonstrates that neither of these things can *safely* be used by the novice, though they may be used by experienced hands with some advantage. The safest method, though, to follow, is to use Gishurst's compound for the scale, and leaf mould as mulch. Of that more anon.

SOIL, LOCATION, AND ASPECT.

35. Having explained in a previous paper the peculiar habits and functions of the fibre-roots of the orange-tree—*i.e.*, to seek the surface in search of air—it is almost superfluous to state that the soil most suited to the tree is a porous one, either sandy loam, volcanic, or alluvial. Orange-trees will grow on almost any kind of soil, provided it be sufficiently well drained. Drainage is highly requisite, but especially to keep up the temperature of the soil. An excess of water in the land chokes the pores of the soil, and the air is excluded, whereas if the water is carried off and the air granted free circulation it warms the soil, promotes chemical action, and decomposes organic matter, preparing the food-elements for absorption by the roots.

36. Both in Australia and America the orange has been found to do best on light virgin-forest land—land that has not

been robbed of its vegetable matter. In the orange districts of New South Wales the orange is grown on sandy loams, which, as a rule, are underlaid with marl or shale strata. I have stated before that the orange does not depend so much on any inherent fertility of the soil as on an abundance of moisture and heat. A fertile soil is, of course, a great advantage, when so situated as to command these desiderata, but porousness is of more value than "inherent" fertility. Food for the tree can be supplied artificially, but Nature should supply the other. Where the soil is porous it has this advantage: that, if a water-supply be available, the orangery can be irrigated during the hot summer months, by which means moisture can be combined with heat. There are many sites to be found with waterfalls upon them, and at a very little cost the water can be thrown all over an orangery with this power. Some loamy lands are of great fertility, and these when found are no doubt the best for the orange-tree.

37. The black loam is the best of all soils, in that its temperature is the highest. Black soils rise in the sun from 65° to 88°, and chalky only from 65° to 69°. Volcanic land varies considerably in quality, but the bush volcanic land should be almost equal to the black loam, providing it has a natural drainage. Some of the volcanic lands are very shallow, and have bad subsoils that do not afford good drainage. These are to be guarded against unless the planter intends to drain. There are seven-year-old orange-trees on volcanic land at Whangarei now with the foot-rot, induced no doubt by want of drainage.

38. The alluvial river-flats should also be nearly equal to the black loam; and where the bank of the river is high, and the natural drainage consequently good, no better land or position could be desired. Light, sandy, and gravelly soils contain little organic matter, but, as a set-off against that, they have the smallest capacity for absorbing and retaining moisture. In hot dry seasons, true, trees upon such soils suffer for want of water, but mulching overcomes that difficulty. In previous papers I stated that, in Australia, planters mulch with forest leaves and leaf mould, which act both as mulch and manure; but I have been told that it would be difficult to follow that system of cultivation here, as leaves and mould would be hard to get. Other things might be used with equal benefit, however.

39. Any light material—fern, for instance—that would sufficiently shade the ground without preventing the passage of rain into the soil would answer. Litter of all kinds, straw or hay, the haulm of peas and beans, sawdust, decomposed

manure, or any kind of vegetable matter in a rotten condition will answer the purpose, and also act as fertilizers. Mulching keeps the surface cool, retards the evaporation of moisture from the earth, and preserves the roots near the surface from being scorched. It keeps down too the weeds, and saves labour that way. But, says another person, mulch would harbour crickets, &c., and do damage. Quite the reverse. Crickets, &c., usually abound in soils that crack and open to the sun, and if the land were mulched it would not crack and open; and again, if crickets still came, the mulch would act as a trap to catch them. If a light roller were run over the mulch, it would make short work of the crickets. Mulch should never be put close up to the stem of a tree.

40. *À propos* of crickets, it is well to state that they can be destroyed by arsenic mixed with stewed apples, or oatmeal flavoured with aniseed. A still easier plan than any of those yet mentioned of mulching and manuring the land is that of growing a green crop in the orangery, and allowing it to rot upon the ground and afterwards chipping it in. It is a plan that I intend pursuing myself. By planting a crop of cow peas in the orangery, in September (care being taken not to plant within a reasonable radius of the trees, so as not to interfere with the soluble manures required by the fibre-roots), the weeds will be kept down, and in summer the ground will be mulched with the haulm. In the fall the decayed haulm can be chipped into the soil. It supplies an abundance of organic matter. It gives to the soil not only what it takes from the ground, but also the carbon, oxygen, and hydrogen it absorbs from the atmosphere.

41. It is a moot point whether plants of this character—leguminous—cannot assimilate free nitrogen from the air; but, whether that is so or not, it is a fact that the decomposition of the crop yields carbonic acid, which in its turn assists in preparing the chemical elements in the soil for absorption by the roots. In the fall green oats can be sown, and similarly treated to the peas. The growing of green oats in frosty situations is particularly advantageous, as the oats by taking up the soluble manures in the ground check the flow of sap in the orange-trees, and thus render them less susceptible to the effects of the frost. Thus two birds are killed with one stone. Green oats, however, should not be grown unless the situation is a frosty one, as the checking of the sap-flow of orange-trees is not by any means advantageous. Orange-trees thrive best in situations where there is no frost, and where, consequently, the circulation of the sap is never interfered with. Such situations are not plentiful, but there are a number of such to

be found in the sandy bays on the coast between Whangarei Heads and Russell. This question of mulching is a digression from that of soils, but it was necessary to show under what system of treatment light soils are held to be superior to any others for the purposes of the orange.

42. Clay soils have not yet been mentioned, and they will only now be reverted to with a view to condemnation. In condemning the clay soil, it is not alleged that the orange-tree will not grow upon it, but simply that it will not flourish. Clay soils absorb much water, and part with it slowly, and hence are colder than sandy and gravelly soils. Even with subsoiling and draining the orange-tree does not thrive on clay land, not only because it is colder than lighter soils, but because it does not admit the air freely to the fibre roots. In summer it dries and cracks, and in doing so destroys the hair-roots of the orange-tree which come up to the surface. In support of the statement that clay soil is unsuitable, I may state that, although the orange succeeds so well on one side of the Parramatta River, on the opposite side very few trees are grown owing to the clay subsoil.

43. In the Whangarei district many instances have come under my notice of trees being planted on clay lands and dying. Mr. Miller, grocer, informs me he planted fifty lemon-trees in 1883 at Parua Bay, and they all died. He has planted another fifty this year on more elevated land, but they too, he says, appear to be dying. Mr. Horn, jun., planted fifty orange- and lemon-trees on his section at the foot of Look-out Hill last year, and they nearly all died. This is accounted for by the clay being too cold: the pores of the land being choked with water, and the atmosphere being unable to circulate to warm it. Added to this, the fibre-roots are smothered and not able to breathe air from the compactness of the soil. The temperature of the tree is lowered to such a degree on this soil that, when a frost comes, the tree withers before it as if under a scorching fire. Those who attempt to grow oranges on clay land which is not naturally drained to a considerable depth will fail; and those who grow them even on well-drained clay land will never derive any great measure of benefit from the cultivation.

44. So far, I have only alluded to the quality of the soil required; but there are other requisites that must not be forgotten, namely, location, proximity to fertilizers, and the lay of the land. Oranges are bulky. One tree carries a hundred dozen fruit, or from ten to twelve boxes; an acre would produce from a thousand to twelve hundred boxes, and ten acres from ten thousand to twelve thousand boxes. You

do not want to have to cart that bulk far. It is not only costly, but the fruit is not improved by being jolted over our not very even roads. If the fruit had to be shipped any distance afterwards, it might spoil from being bruised. This calculation must be kept in view when selecting ground for an orangery.

45. Water-carriage, where there is no railway, is the best for the orange, and proximity to a navigable river should not be lost sight of. Another advantage of being near a river is that the mud of a fresh-water river is one of those manures that can be applied with great advantage to the orange-tree. Some of our northern rivers—such as the Northern Wairoa and the innumerable other rivers which serve every northern district—are moving masses of decomposed vegetable matter, a never-failing source of wealth and fertility if properly applied. The leaves and undergrowth of the forest, being washed into rivers, decompose slowly, and, being excluded from the atmosphere, lose little of their original elements. These rich and vast deposits have been stored up for ages, and lie ready for the use of the orange-grower. Large areas of the most suitable orange land in the North are virtually unavailable at present for the want of means of transit. When the North Auckland Railway is made, it will open up some of the grandest orange locations in the Southern Hemisphere.

46. Next, in selecting an orange ground, it is necessary, amongst other things, to see that the site is favourably situated in regard to frost. Frost, it is well known, is very eccentric in its movements. It is patchy. It strikes one point and misses another close by. An air-current, like a current of water, flows along till it meets any obstacle, and then, like water, it flows over or round it. Frosty air-currents travel from the south, and where a hill is met the volatile flow goes either over or round it, falling here and there on its direct course, while, to the side, eddies form and set up a circular motion, gradually decreasing in strength as the distance increases from the main frosty air-current. Some spots are nearly free from frost; others are so subject to it that delicate plants are scorched and killed by it.

47. When there is sufficient shelter from the morning sun, a little frost does no harm—in fact, does good, for it kills much insect life. But keep out the morning sun, or the young shoots of your orange-trees will be "scalded," or even the sap of the trees may be frozen, and the shrub greatly injured and probably killed. There are still other things to be kept in view in selecting the future orange-grove. Lime is a valuable help in connection with orange-culture. It is useful to

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throw over decomposing mulch, particularly over the green crops, peas, oats, &c. It is equally useful to mix with river-mud.

48. The chief chemical component of the orange-tree is lime; hence the tree requires it as food. Experience has proved that orange-trees, before they reach the bearing state, require nitrogenous manure, and, after they have begun to bear, alkalies. It is an advantage to have lime handy, as it is another of those fertilizers useful to the orange-tree, and many of our northern districts abound with it. Proximity to a forest means nearness to forest leaves or leaf mould—considered in Australia by the oldest and most experienced planters the best of all materials for orange-culture, being an excellent mulch from its lightness and penetrability, and the most suitable of all "nourishers" from the slowness and regularity with which it feeds the tree with organic food. It is the homœopathy of orange-culture. Like cures like—leaf mould supplies the tree in minute doses with that of which it has been deprived.

49. No artificial manure is known that contains the exact constituents required by the orange-tree, and all are too stimulating, and if used without caution would produce the same effect as spirits on a man, elevating but not strengthening. Hence nearness to a forest is important. Wood-ash, too, which is readily made where there is abundance of timber, is useful on an orangery. It is a good fertilizer, and is an equally good insecticide. Where green crops are grown amongst the trees, insect life is sure to be prevalent, especially with cow peas. Wood-ashes are death to them.

50. In regard to the lie of the land, a gentle slope is the best, and a dead level the worst. There should be enough fall for the surface drainage. More than sufficient slope for that purpose would be detrimental if it militated against the working of the plough, as it would necessarily increase the cost of cultivation. But in Australia steep hill-sides are not despised for orange-cultivation, and are taken in preference to level lands where there would be a danger of the drainage not being good. The best aspect for an orangery is a northerly one, and, if the sun does not rise upon it till 10 a.m., it is no disadvantage but the reverse, as it would not then thaw the frost so quickly. A northerly aspect is infinitely preferable to a north-east one, excepting that the grove be free from frost.

SHELTER, AND EFFECTS OF FROST.

51. The importance of shelter in orange-growing is paramount, not only as protection against cold and cutting winds, but more particularly as shade from the morning sun. The

rays of the morning sun falling on a frosted tree do infinitely more harm than the cold winds from the west and south, though these are bad enough, and will often entirely check the growth of a tree. Particular attention must be paid to have "shade" shelter on the east in all positions liable to frost, and from this it will be seen that the best aspect for an orangery is a northerly and not a north-east one—an aspect where the sun will fall upon the trees from, say, ten a.m. to near sundown. Mr. A. T. Holroyd, of Parramatta, when giving evidence before the Commission, spoke as follows:—

From my experience, and watching the growth of other orchards, I have arrived at the conclusion that oranges, as a rule, can only be successfully grown upon a northern aspect. I found that it was necessary to shelter the trees on the east, the south, and the west, and, if possible, slightly on the north-west. The reason for shelter on the east is this (and I noticed it for two years in Mr. Oakes's orchard, Parramatta, before I commenced planting): All the autumn shoots of the orange-trees in Mr. Oakes's orchard, which has a slope toward the east, were killed by what is called in orange language "scalding." This is caused by the morning sun coming upon the autumn shoots before the frost is dissolved. It occurred to me that if I kept a shelter on the east, and allowed the sun to rise over the trees, and warm the atmosphere and dissolve the rime on the trees before the sun impinged upon them, they would be saved. This year, though we have had the hardest frosts I have known in the district, I have not seen in my orchard a single leaf or shoot affected by the frost.

52. Mr. Pye stated it to me as his opinion, and these are his own words, "The morning sun does more harm than anything else." I have already explained that the effect of frost upon an orange-tree was to freeze the sap—the sap of the orange-tree being composed mainly of water. When water freezes it expands, and the sap when thus expanding ruptures the cellular tissue, into which the oxygen of the atmosphere rushes, and, in combination with the sap, causes fermentation, When a tree is frosted, the morning sun will thaw the frosted sap, which contracts into its former bulk, leaving avenues between the sap and the bark, into which the oxygen of the air, as before demonstrated, finds access. Hence shading a frozen tree will, as a rule, prevent injury. There are two things to be thought of in regard to frost, namely, how best to shield off the frost so as to reduce its force to a minimum, and next how to shade the trees from the morning sun. Till quite recently many persons in the Whangarei district thought that oranges would never succeed here because of the frost, and more particularly because a number of persons who had planted trees had lost them all from the effects of frost. During the past autumn a large number of trees have been destroyed from this cause, the planters not knowing that shade from the morning sun was all that was required to save their trees. All orange-

growing countries are subject to frost more or less, and most of them to a far greater extent than North Auckland.

53. The finest oranges sent into the English market go from the Azores, a number of volcanic islands in the Atlantic, and situated between latitudes 36° 55′ and 39° 44′, in a latitude equal to that represented by the district lying between Kawau and Napier. North Auckland, it will be seen from this, is comparatively in a warmer latitude than the Azores, though in reality, of course, the difference is not so great as it appears, as it is colder in the Southern Hemisphere than in the Northern, owing to the effects of ocean currents. Taking Florida, on the other hand, which is much nearer the equator, being between the 25th and 31st degrees of latitude, we find that frosts are much more severe there than here, though that is one of the finest orange-producing countries in the world. One writer on the subject of orange-culture indicates this very plainly. He says,—

As to "the frost line," there is no portion of the peninsula of Florida that is not subject to occasional frost. I have seen the effects of frost as low down as Fort Myers. Persons whose statements are entirely reliable, and residents of the section, have told me time and again that they have occasionally had their vegetables killed on the extreme southern capes of the peninsula. That frost is modified by latitude there is no question; that the southern portions of the State are less liable to frost than the northern portions there is no doubt; but do not deceive the immigrant by saying or implying that any portion of the mainland of Florida is entirely exempt from frost. And I do not know that this is to be deprecated. For while "Jack Frost" is an unskilled pruner, and by the little cutting he does in Florida may do some hurt, yet I think upon the whole both the orange-tree and the health of the inhabitants are the better for his visits. I am sure my own orange-trees were never so free from insects and in so healthy condition as to-day, eight months after the frost of December, 1880. Many groves in a most flourishing condition, and supposed to be well located with reference to protection from frost, some far south and with considerable water to the north-west, were seriously damaged in the winter of 1876–77, and many trees beginning to bear entirely killed; but the writer has not heard of a single instance of damage to trees in that winter where they were protected by forest trees standing to the south and east of the oranges. Even the lemon, in 1876–79, much tenderer than the orange, was unhurt where so protected. One other instance. On the south or south-east of Orange Lake stood two beautiful and extensive orange groves side by side. They were wild groves budded and just coming into bearing. They both had the same water protection. One grove was judiciously protected by forest trees left standing at suitable intervals; the other grove was without such forest protection—all the forest trees had been cut down. A few days after the severe frost of the winter of 1876–77 the sheltered grove was still as green as in midsummer, while the other appeared as though a fire had swept through it. Its leaves were dead or fallen, while thousands of dollars' worth of fruit, frozen and spoiled, hung on the naked branches. The owner estimates that if he had left a few forest trees in his grove they would now be worth to him twenty thousand dollars.

54. The whole of the orange-producing districts of Spain lie between the 36th and 40th degrees of latitude, or equal to the district lying between Waipu and Wanganui, so that it will be seen that we have the advantage here in the north of being well situated in regard to climate. Portugal, from which country England imports oranges largely, can grow fruit as far north as Oporto, in latitude 41° 9′, or about the latitude of Wellington. In these very cold districts of Europe, however, where the orange is grown, the trees are planted close together, and in winter are protected. Napier, I think, will be the southern boundary of the orange district of New Zealand; and I know of no better place anywhere than the town of Napier itself, where the soil is sandy and calcareous, the heat in summer intense, and much of the land on the hillside affording a good natural drainage. I am only referring to the coast districts: inland it would be too cold. Below are the latitudes of different countries in which oranges are grown, from which planters will see there is no necessity to fear the frost, providing they adopt necessary precautions:—

	°	′		°	′
Spain	36	0	to	43	0
Spanish orange districts	36	0	„	40	0
Azores	36	55	„	39	44
Portugal	36	55	„	42	8
New South Wales orange districts, chiefly between	33	0	and	34	0
New Zealand	34	15	to	47	30
North Auckland	34	15	„	36	50
Florida	25	0	„	30	0
Malta				35	53

Here, in North Auckland, we have one of the finest orange countries in the world, as the above latitudes must prove—fully equal in point of situation to either Portugal, Spain, the Azores, or Malta; but we must not expect to grow good oranges without ample shelter from the cold winds and frost. I have plainly demonstrated, I trust, that we have no need to fear the frost here so long as proper precautions are taken.

55. We must not, however, forget the imperative necessity of providing shade from the morning sun. First of all we will deal with the shelter from the cold cutting winds and from frost, that is, the southern and western boundaries. I am assuming, of course, that there are no natural breakwinds; we will deal with them afterwards. The southern boundary should be as thick and compact as a wall, as it not only has to act as a breakwind, but also as a shield against the frost or freezing

air-currents. No matter how high and thick you grow such a shelter the air-currents will still roll over the top, but a large proportion of the orange-trees will be wholly missed. Where it is possible for such a shelter to be convex in shape, the frosty air-current, instead of rolling over the top, will glide off the rounded sides and pass on. The shelters to the west and east should in the one case be a "breakwind," and in the other a "sunshade." It is important to bear in mind that it is not necessary to wall an orangery completely in and stop the free circulation of the air, but merely to break the volume of the wind to destroy its force. For this purpose it is not necessary to grow a compact shelter, but rather something in the nature of a sieve—something through which the wind can pass, its momentum having been destroyed. If an orangery or orchard were completely walled in it would suffer for want of fresh air, for it would be like a deep box with its lid off. Being full of air just as if it were full of water, it could not take any more, and the tendency of the air-currents would be to pass over the top without in any way supplying new life-food to the orangery. The momentum of the wind being broken it should be allowed to pass on to keep up the free circulation of air in the orangery, and for this purpose the best way of growing a breakwind is to plant two rows of trees, in the form of a zigzag, so that a whole face is offered to the wind, which, when broken, can pass on through the intervals between the first and second lines of trees.

56. The sunshade can be formed in the same way. For the southern boundary, *Pinus insignis* and *macrocarpa* make the best and most compact shelter, and grow very quickly. For the other boundaries poplar-trees closely planted are the best. Though leafless in winter, if planted thickly they are sufficient to break the wind, and also are shade enough against the sun. In South Africa, nothing but the poplar is used for this purpose. They also produce a great crop of leaves, which, as already explained in other places, are of the greatest value in orange-culture for mulching. Where these shelters are grown it is necessary to cut a drain 3ft. deep between the shelters and the orange-trees to prevent the roots of the former interfering with the latter. In Florida drains of this kind are filled up with leaves and refuse, and used the following year for fertilizing. In South Africa these drains are filled up with concrete, as a permanent barricade against poplar roots. For intermediate shelter, there is no tree equal to the loquat. It is a quick grower, an evergreen, and produces a good crop of leaves annually, besides fruiting.

FOREST PLANTING AND NATURAL PROTECTION.

57. No doubt, most orange-planters of the future will seek out situations naturally sheltered, where the forest will answer as the breakwind or sunshade, or both combined. Where such situations can be found their value will be very great. Such sites are not easily found with suitable soil and natural drainage. The simplest plan seems to be that practised in America and South Africa—namely, of clearing openings in the forest either by running long narrow "streets" right through the forest, or by clearing small squares of from a quarter to an acre in size. Large sections of land are laid down in this way in Florida, the forest being allowed to stand in 50ft. strips between the different sections. The fallen timber, of course, has to be burnt, and the wood and ashes are very beneficial to the soil, but the cost of logging and stumping the ground, I should think, would prevent that system being pursued here. It gives settlers, however, a good wrinkle how to make use of forest shelter. This system could be taken advantage of on tea-tree land, where the soil is suitable, as the timber is easily handled, and would always pay for removal as firewood, or it could, in the meantime, be stacked. This kind of land is limited in extent, but here and there good alluvial river banks are to be found with this growth upon it. The Rocky Hall Estate of Mr. Pye's, at Parramatta, is enclosed by blue-gum forest, and his four big trees, which, as before stated, are eighty years old and 37ft. high, are growing in a sheltered nook, where the sun does not fall upon them until late in the morning.

58. When trees are planted they should be covered with tea-tree boughs, if the situation is a frosty one. The first year I planted I followed this plan, and, in spite of severe frosts, my trees were not affected. The following year I was persuaded that the tea-tree harboured insects, and were otherwise injurious, and I planted trees without any protection. The consequence was that a number of trees were killed, and all more or less injured: in fact, very great harm was done. There are, however, positions where such shelter is not required; but planters, to be on the right side, had better erect the shelter. Mr. Weaver, nurseryman, lost all his trees from the severe autumn frosts of 1884 for want of shelter, and very many settlers suffered in the same way. I noticed the nurserymen about Parramatta cover all their yearling stock with tea-tree scrub. In the North of Europe, frost guards or *paragelées* are used for all sorts of fruit trees and vines. These act on the principle of a lightning conductor, by sending the frost to

water. *Paragelées* are made of cords of straw, hemp, or the rind or bark of trees. With the cord the fruit trees are surrounded, and the ends drop into a vessel of spring water. One vessel will do for many trees if the cord is continuous.

TRANSPLANTING; DEEP AND SHALLOW CULTIVATION.

59. Having secured a suitable site for the orangery, the laying of it out and preparing the soil are the next things to be considered. The soil for the grove should be thoroughly prepared before a tree is set in it. It should be ploughed and harrowed two or three times until it is broken into a fine tilth, and the weeds as far as possible eradicated. The soil should be levelled as nearly as practicable to insure the trees being set at an uniform depth. If these matters are neglected, much trouble will follow as a consequence. Great care should be taken to thoroughly clear volcanic soil of old fern root, as the fungus—popularly called the "death-fog"—is frequently found attached to it. This fungus will kill any tree it attacks. The same fungus is found in the Azores. The treatment for it will be found under "Foot-rot." The best time for transplanting trees in the North Auckland district appears to be in winter from May to July, selecting, of course, suitable weather. In Australia the practice has been to plant 100 trees to the acre, that is, at 22ft. apart, quincunx fashion; but it is admitted on all hands that it would be far better for the sake of the tree if only half that number were planted to the acre, so that the immense root system of the tree could have ample room to develop itself. It is urged against this system that most of the land of these intermediate spaces would be lying waste for upwards of ten years, while the whole of the land would have to be worked and kept clean.

60. The advisability of growing short-lived fruit-trees in these spaces has been discussed very fully, with the result of no definite conclusion being arrived at. Some planters argue that, if any trees are to be grown intermediately, orange-trees might just as well be grown as any other fruit trees, and these intermediates could when required be cut out. On the other hand, it is argued that if any kind of intermediate trees be planted the effect is the same—the soil is robbed of that which the permanent tree will presently require, and then manuring has to be resorted to, with the result of the longevity of the tree being discounted and the quality of the fruit destroyed. In some parts of Europe the trees are planted only 10ft. or 12ft. apart where artificial covering has to be resorted to during winter, but then a quantity of the blossom is picked

off and sold for the manufacture of perfumes. In some instances, planters use the ground between the young trees for market-gardening, not cultivating within some feet of the stems of the trees; but the system is condemned by those who believe in giving up the whole of the land to the orange. Planters must use their own discretion as to how many trees they will plant to the acre, and they will probably be guided in so doing by the system of cultivation they purpose following—that of shallow or deep cultivation; but it is as well to know that the roots of orange-trees will extend 40ft. from the stem.

61. The consideration of this matter is a very important one, and I need hardly say that both systems have enthusiastic supporters. The matter, however, will, in the majority of cases resolve itself into a question of £ s. d.: as to which system will pay the best, that is, which system will return the *largest percentage* of profits on invested capital, and also as to the amount of capital a planter has at his disposal. It may go without argument, and without prejudice, that the deep system—that is, trenching—will produce the largest crop; but that does not necessarily imply a larger measure of profit. The net amount of profit is calculated by the percentage on the capital invested. For instance, the Rev. Mr. Moore, of Florida, who is an out-and-out supporter of deep cultivation, in his work on orange culture, argues as follows:—

> Now, if trees have been set 20 feet apart in the grove and the soil is drained but one foot deep, the roots of each tree have but 400 cubic feet of soil in which to feed—20 × 20=400. But if the soil has been drained to the depth of 10 feet, then the feeding ground for the roots has been increased tenfold, and, instead of 400 cubic feet of soil in which to feed, the tree has 4,000 cubic feet—20 × 20 × 10=4,000.

This deduction is obviously wrong, because chemical analysis demonstrates that the greatest fertility of land lies on the surface, so that the number of feet of drainage would not be the true multiple of the land's productive power.

62. Of a truth, trenching and draining must improve the fertility of any land, but every foot deep of drainage would not imply a gain of a foot of surface fertility; and, in regard to orange-culture, it appears to be a moot point whether it is not, in the case of some soils, a positive injury to trench the ground. The authority above quoted admits that he has only had ten years' experience of orange-growing, against which I would place the experience of the Australian planter, Mr. Pye, who has the advantage of seventy-five years. Giving evidence before a Parliamentary Commission he said: "I can show some old orchards—forty or fifty years old—doing well,

although they have never been trenched. . . . A neighbour, who has some of the finest young trees in the country, has gone to a great deal of expense trenching; but I can show trees equally good on the old plan. . . . At Castle Hill, which I do not think is worked more than six inches deep, I have never seen a tree go bad, though so many trees have died elsewhere." Another very old planter, Mr. W. H. McKeown, said: "The land *was* trenched in my orchard and not drained, and I lost a good few trees from foot-rot previous to 1865. In going about the country, I noticed that trees that had not been very much cultivated, where the ground had not been dug very much about the roots, were not so subject to the disease; but these neglected trees did not bear so heavily."

63. From this it would appear that, with a porous soil and natural drainage, the shallow system does at least answer the purposes of orange-culture. There is no necessity to inquire into the other system, as it is more costly—involves the expenditure of a considerably larger sum of money, with the prospect of a smaller percentage of profits. Rather, indeed, than spend money in sinking drains and trenching, it would appear the more practical, and certainly the more economical, plan to give the trees the extra ground on the surface, where land is not too dear. With land at £15 an acre, it would be cheaper to give the trees double the surface than to go to the expense of trenching and draining. However, it is a matter for planters to decide themselves, according to circumstances and to their ways of thinking. Where there is not natural drainage, the tiling of the land must be undertaken. Open drains can, of course, be used where they do not interfere with ploughing. I would remark, before leaving the subject, that it is well to bear the following points in mind: that where the trees are planted from 30ft. to 40ft. apart, and the ground between them is kept clear of weeds and broken up for a period of years, the chemical process going on in the soil slowly but surely increases the fertility of the land; slowly but surely a great mass of plant-food is being stored up for the use of the orange-tree when it arrives at maturity, and requires greater supplies for the production of fruit. Cropping the land would have the opposite effect. Planters will often say that what they take out of the land in crops they return again in the shape of manure. But do they? Don't they take a little advantage of the soil, being anxious to make money quickly? No one can have his pudding and eat it too. Another point is this: that the efficacy of shallow cultivation is amply demonstrated in the North Auckland districts by the old trees that are growing and bearing heavily—trees that were planted

without any special care and have had little attention. The ground was not trenched for them. Mind, I am always assuming that the soil is porous and not a clay.

64. Shallow System of Planting.—The methods of planting the trees under the two systems are, of course, different. Mr. Pye explains the method of planting under the shallow system as follows: "I plant the orange-tree as near the top soil as possible, not more than three inches from the surface. I collect the soil around to cover the roots. The soil under the tree should not be worked so deep as that further away—the water then will run away from the tree. For about three years I plough the ground, and every time I plough towards the tree, so that I collect a good depth of soil. This brings it up to a nice round, and leaves a surface drain for the water. I advocate ploughing till the fourth year. The tree should be planted as shallow as possible, and every time the ground wants cleaning it should be ploughed towards the tree, leaving a furrow drain between the trees. My drains are a foot deep. When the trees are bearing, the ground is never dug, but chipped over with a hoe—just scraped, in fact." Mr. Pye advocates bending the tap-root, and, if necessary, putting a slab under it.

65. Deep System of Planting.—The way to plant for this system is lucidly explained in Mr. Moore's work:—

The holes should be dug in the shape of an inverted saucer or truncated cone with about two inches of the top cut off. Proceed thus: Around the stake which marks the place for the tap-root, with a shovel or hoe take away the soil, letting the tool strike the top of the soil at the stake, and continue to dig deeper into the soil until at a distance of 18 inches from the stake it has penetrated six inches below the surface. Proceed thus around the stake until it is completed. This gives the greatest depth of the hole on the outer edge or perimeter of the circle. Now take up the stake, and cut two inches of the top off the cone. Where the stake stood, push down the spade by working it back and forth until it has penetrated the ground about 18 inches, or the full length of the tap-root of the tree to be set. Now insert the tap-root in this hole made by the spade. Be careful not to set the tree deeper than it grew in the nursery. With the hand pack the soil firmly around the tap-root. Next spread the lateral roots over the cone, taking care to distribute them evenly over the cone. Throw on two inches of dirt and press it firmly with the feet. Finish by throwing in soil and levelling the ground, leaving the last layer of soil untrod.

If planting is done in summer or in hot weather, and the ground is not protected by forest trees, it is better to mulch.

If trees are older than three years, and wild-grown [Mr. Moore refers to budded wild trees, which, of course, are not obtainable here], it may be necessary to dig the holes deeper than directed above, but the point of this caution is against deep setting. The writer is satisfied that more trees have been diseased and retarded in their growth, and frequently killed, by deep setting than by any other one cause.

66. All authorities are agreed that no greater mistake can be made than in planting orange-trees in holes: in fact, the tremendous destruction caused to the orangeries of New South Wales between 1860 and 1870, after excessively rainy seasons, was attributable chiefly to this system of planting; and now just the reverse method is adopted, that is, of planting as it were on the top of an inverted saucer. A number of persons here in the North have, I know, planted their trees in holes, and the only remedy is to now dig the ground to the same depth, so that there can be no lodgment of water under the trees. My trees were planted in holes, and to guard against the danger of foot-rot I have, since my visit to Australia, had strips of ground dug right along each line of trees. Another important matter to be observed, and one upon which there appears to be no division of opinion, is that no manure should be used when planting, as the wounded roots would at once ferment did they come in contact with manure.

PRUNING.

67. Pruning is one of those subjects upon which I find orange-planters in different countries disagree. We will approach the subject, however, by a physiological inquiry into the functions of the leaves, &c.; and afterwards the inquiry can be extended into practical experience and usage. The leaves, botanists tell us, serve the purpose of exposing to the action of the sun-light and sun-heat the food materials absorbed by the plant, and thus cause assimilation;* they also provide for transpiration;† and they absorb the carbonic acid of the air; also that the stomates or breathing-pores of the leaves open more widely

* The process by which the carbonic acid absorbed by the leaves and the water absorbed by the roots are combined together in the leaves under the influence of sun-light to form starch, free oxygen being at the same time given off, is called assimilation. The starch so formed appears to be dissolved in the cell-sap during darkness, and to be distributed from cell to cell all over the plant. It is used up wherever growth is taking place, furnishing the material for the formation of the cellulose of the new cell-walls, or it is stored up again in the solid form, as a reserve of material for future use, as in seeds.

† The sap, on reaching those surfaces of plants that are exposed to the light, parts with a great deal of its water as vapour, both through minute pores in the leaves and elsewhere, as well as through the walls of the superficial cells. The pores are called stomates; they exist in very great numbers, chiefly on the underside of the leaves: an apple-leaf presents upwards of one hundred thousand of them. This process, called transpiration, keeps the plants cool in the hottest weather, and is so rapid that a sunflower plant has been found to give off a quart of fluid in twenty-four hours, and an oak or beech-tree must give off many gallons in the same space of time.

in the light than in the dark. These leaves, to serve their purpose well and fully, require to be so exposed as to have an abundance of sun-light and sun-heat. If the tree grows into a compact bush, the interior must be dark, and the leaves there could gain little from sun-light and sun-heat. The question then is, Would it not be better to cut these out if they serve no purpose, and do, most likely, positive harm by choking or impeding the free circulation of the air? On the face of the matter, one could arrive at no other conclusion. And here I publish the views of an American writer on the subject. He is very pronounced on this head, and gives his reasons in such a clear and lucid manner that I publish his views *verbatim*:—

Pruning is universally adopted by Nature. In the forest all the branches of the little oaks and pines are near the ground, but as the trees grow these lower branches die and drop off. A few years later we behold thousands of graceful, well-trimmed trunks. Where the oak grows up in the open field its method is to prune the inner branches and extend the surface, giving what fruit-growers call an "open head." The grape-vine prunes itself. Where its branches are thickest the tendrils first strangle, and then cut off, some of the excessive branches. It is the Divine plan. "I am the true vine, and my Father is the husbandman. Every branch in me that beareth not fruit, He cutteth away; and every branch that beareth fruit, He pruneth it that it may bear more fruit." Wise is the man who will follow such teaching. Happy is the man who has a taste for such work, and can take up the vocation first taught man when "the Lord God put him into the Garden of Eden, to dress it and to keep it;" especially where he can dress a garden of this golden fruit—a relic of Eden—that is "pleasant to the sight and good for food." It may be said, "If Nature prunes at all, let her do it all." Yes; and it may be said, "If Nature plants and grows the corn at all, why should I take the trouble to plant and cultivate?" But such a man will reap little more than the harvest of his folly and indolence. Nature makes suggestions, but does not propose to do all the work where man's interest is especially concerned. Even before thorns and briers had sprung up, it was man's duty and to his interest to "dress the garden" so perfectly planted. Again, where Nature prunes, knots and dead wood often become the starting-points for extensive decay; but where a living branch is cut off with a sharp knife from a vigorous tree, the wound soon heals over, leaving no scar nor injury. The writer has practised on a grove of about four thousand trees all the methods of pruning, and not pruning, to satisfy himself as to the best method. Nor has he spared himself the trouble of visiting many of the best groves in the State, watching the operations of others, and questioning them closely as to their practice and the results. He will not trouble the reader with the many theories advanced, much less with discussing them. A few essential points are all that are necessary to be attended to. In pruning, the sharper the knife or saw, the better. Let the cut be clean and smooth. When the knife is used it is better to cut *up* than down, as the downward cut is apt to split the wood and peel off the bark. Do the principal pruning in the spring. By all means avoid fall or winter pruning, as it is apt to start new wood at a time when it is most exposed to damage from frost. Cut off all dead wood, and up to, or a little into, the living wood. Thereby the wound heals more readily. As a general rule cut off all diseased branches, espe-

cially if they have become so far diseased as to fail to develop healthy leaves. Give and keep an open head to the tree. To do this, select the most vigorous lateral branches, leaving some on all sides of the tree, so as to obtain a head as uniformly balanced as possible. After cutting off the other branches close to the trunk, trim up these selected branches almost to a point, leaving only a few of the terminal smaller branches. When this is done the tree will likely conclude you have used the knife too freely. But if this pruning has been done in the spring, and you keep the "water" shoots pulled off the trunk, and cultivate well, you will find the trunk by winter enclosed in a beautiful head, with a dense wall of foliage on the outside. The next spring, trim these laterals in a similar manner, allowing the first laterals to rebranch a little distance from the trunk so as to be able to fill up the larger area by fall. Continue this method till your tree is large enough to bear its first crop. You can then slacken your pruning so as to encourage the fruiting. There are several advantages arising from judicious pruning. When a branch dies, it not only ceases to benefit the tree, but becomes a drain on its sap and vitality, as an ulcer to the human body. The same is true, to some extent, with a diseased branch. Moreover, as a branch begins to die, its fermenting sap is slowly taken up into the general circulation, and so the disease extends itself sometimes to the entire tree, unless it be cut off below the sound wood. This is especially the case when the frost has partially killed the young wood. The writer has known quite vigorous trees to be killed, not only to the ground, but entirely, by neglect at this point. The open head not only gives room for the free circulation of air through the branches, but also enables the gardener to watch the trunk and larger branches, and remove from them insects that might prove damaging. Another advantage arising from the open head is, it causes the lower branches to extend themselves far out from the trunk, and so gives a greater bearing capacity to the tree. Trees in the grove of the writer, pruned after this plan, have doubled in development within two years, in their surface area, others standing by their side with the same treatment, except that the latter were not pruned.

68. Against these views, however, I must state that in Australia, as a general rule, pruning is only practised but moderately, many planters believing that it is sufficient to prune the tree into shape when young, and when full-grown simply to cut out the dead wood. This is the practice pursued by Mr. Pye. Other planters, on the other hand, told me that they *believed* that the trees were not pruned half enough; but, in that the trees were not pruned so extensively as indicated in the above extract, there was no practical information to be had on the subject on the other side. Mr. Moore, Director of the Sydney Botanic Gardens, in his report on European orange culture, says, in alluding to the orangeries he visited in Spain, "The trees are only pruned to the extent of cutting out the dead branches." And in another place he says, "I could not learn that any regular system of pruning was adopted." Further on he points out: "In the general management of the orangery our colonists have little to learn from the people of those countries, who, in this as in most other respects, continue to tread in the footsteps of their fore-

fathers. The mode of working the soil and the implements used, being of the most primitive description, are now apparently the same as in ages past."

69. From these observations it would appear that the information to be obtained in such unprogressive countries as Spain is hardly worth consideration—in fact, would be more liable to mislead than to guide. Hence it would be impolitic to be guided absolutely in the matter of pruning by the practices pursued in Spain, although the practice there appears to be very similar to that obtaining in Australia. It is too much the fashion in these colonies for people, when talking or writing about these industries, to take it for granted that, because such-like industries are pursued in certain European countries, the most perfect system of cultivation is to be found there. I would rather rely on the judgment and observation of a keen, intelligent American than on that of the dull, unprogressive Spaniard. Take Italy as a point in instance. The vine can be grown there as well as anywhere in the world, yet the Italians are the worst wine-makers, and do not make any good wine fit for export. This discursiveness is foreign to pruning, but has its point. The only other authority I have been able to find on the subject is in favour of pruning the "*interior of the tree.*" That authority is Jose de Canto, of the Azores, who in a letter to Mr. Moore, of Sydney, points out how, after the appearance of foot-rot there in 1836, the mode of culture was altered, with the effect of *more abundant* crops, but of an *inferior kind.* He further states that this culture affected the durability of the fruit in such a manner that it would hardly carry to England. He then explains that they had in the Azores in consequence returned to "the old traditional culture," by *pruning the interior of the trees for the admittance of air and light.* That evidence should be conclusive.

70. Some kinds of orange-trees require more pruning than others. The grafted tree always grows up more "open-headed" than the seedling, and wants but little pruning. The seedling grows into a very bushy, compact tree, and is the better for much of the interior being taken out. The Auckland-grown trees have the fault of being grafted too low, and they grow from the ground like a bush, instead of showing a clean stem for at least 2ft. from the ground. These trees would not sell in Australia, as it is difficult to work the ground near them with a plough, and it is impossible to get underneath them to see that the limbs are clean or to syringe them. Those trees should be pruned into shape as far as possible while young.

71. With regard to the lemon-tree, just the reverse appears to be necessary. The *Florida Agriculturist* says on this subject,—

> We have noticed before that lemons do not bear well if trained with a single trunk into the form of an orange-tree, and experience has convinced us of the fact. Five years ago we planted five seedling lemon-plants from seeds of an imported variety. Two of these we trained with a single trunk, and the other three we allowed to grow as Nature dictated, with many sprouts hanging over. The latter has given us two crops of excellent fruit, while we have not got one lemon from the former. We would like to have the experience of others. Reuben Marsh, living near this town, has found this to be the case. He tried for years to train his lemon-trees, without getting any fruit. At last, disgusted with the result, and thinking that he had a worthless variety, he allowed the trees to sucker out and turn into a bush, and now he has large crops of lemons.

The lemon-trees which bear such large crops in North Auckland are all of the "bush" shape, and I feel sure that the above information is correct.

DISEASES: "LAGRIMA" AND "FOOT-ROT."

72. These are two distinct diseases with symptoms very similar, but the one is caused chiefly by atmospheric influences, the other by faulty cultivation. The only difference in the symptoms of these diseases is that in the case of "lagrima," or "bleeding" as it is called in America, there is an exudation of gum from the trunk of the tree. In other respects these diseases are the same, namely, the rotting of the bark around the stem of the tree just at the surface of the ground. This decay extends, in the case of lagrima, subsequently to the crown- and tap-roots of the tree; but with foot-rot the decay may begin in the roots and proceed to the stem. In simple foot-rot there is no exudation of gum, and the decaying bark has not, as in lagrima, an offensive smell. Lagrima is the worst of all diseases known to the orange-tree. It was that disease that devastated the orangeries of the Azores and Portugal in 1836, and of New South Wales between 1860 and 1870. Lagrima has been to the orange-tree what the phylloxera is to the vine. It is induced by an unusual superabundance of rain and an exceptionally cold winter.

73. These combined appear to reduce the temperature of the soil, and hence the temperature of the sap in the roots. The atmosphere recovers its equilibrium first, and soon warms the sap in the branches and stem, and on the fusion of this heated sap of the foliage with the colder sap of the roots fermentation begins beneath the bark, under which the diseased sap collects, first forming a blister, and then breaking through the bark, corroding, and hardening into gum. This matter is

best explained in the following extract from a letter written by one of the largest planters in the Azores to the Director of the Sydney Botanic Gardens. He writes,—

With regard to the disease of the orange in the Azores, I am enabled, from personal observation, to give some information. The disease was first observed in our gardens about the year 1836, but it is probable that for a year or two previous it must have been not inactive, inasmuch as the consequences we then observed were very general and disastrous. At first we noticed that our orange-trees were dying one after another, and were wholly unable to divine the cause; ere long, we found it was our best and oldest trees that were thus disappearing. At that time we had trees producing from six thousand to twenty thousand oranges a year —trees that were as much as two hundred or three hundred years old. By degrees we began to observe that all the trees affected with the disease produced a very large crop exactly in the year the disease manifested itself: that the leaves became yellowish, and fell off in large quantities; and that on the trunks or stems near the ground (and sometimes beneath the ground) the bark opened and drops of a kind of yellow gum exuded. As this last-named fact was in all cases observable where the trees were so diseased, and as the drops of gum took the shape of *tears* (*lagrimas* in Portuguese), the disease was called by us the "lagrima,"—the name by which it is still known amongst the Portuguese orange-growers. At first many orangeries were quite destroyed and had to be replanted, so that a remedy for so great a misfortune was earnestly sought for. Opinion as to the cause of this disease was very much divided. Many thought it must be that the orange-tree had but a limited period for its existence, and that, this limit being reached, the tree must naturally decay. As the only way which we then had for propagating orange-trees was by layers, we thought that the proposed explanation was not an unreasonable one; but later it was found that new *seedlings* were attacked in the same way, although not with so much violence. Then, again, others thought that it must be something in the atmosphere which prevented the free circulation of the sap and the other fluids, and supposed that this must be the origin of the disease. The great point, of course, was to find an easy and practical mode for remedying the evil. Gradually, after repeated trials, we found that *superabundance of moisture in the soil was one of the worst conditions for the disease*, and every kind of drainage was the best way for improving the health of the trees. Soon afterwards we found that the destruction of all the diseased bark and wood in the stem of the tree affected was the best method for us to adopt to save the tree. Now the disease still exists in our gardens, but it has ceased to cause us uneasiness. From the month of February till August a skilled horticulturist visits, month by month, every tree in an orange plantation, inspecting the stem near the ground; and, at the slightest sign of any exudation of gum, he cuts the bark across, so as to allow the gum to run freely out. If he finds the disease in a more advanced state, both the bark and the wood must immediately be cut out until that which is sound shall have been reached, the earth being at the same time withdrawn from contact with the stem, and the largest roots left quite exposed to the air, free from any of the soil, to the distance of 1ft. to 2ft. from the stem. The small roots on the side where the gum has appeared are carefully examined, and every decayed portion of them cut off. Great care is, moreover, taken to prevent the accumulation of rain-water near the stem where the roots are exposed. If the attack of the disease be discovered at an early stage, the tree, by this treatment, is soon restored; and, even when the disease is more advanced,

the tree, by following this treatment, generally recovers. When they are long in recovering we find it more profitable to plant a new orange-tree; and, to provide for such contingencies, we have always numerous supplementary orange-trees in our plantations. Although the disease continues to exist, our gardens now look very prosperous, for the remedy is known, and the disease causes no such ravages as it did for the first seven or eight years after it made its first appearance. Orange-trees take very easily by transplantation, and we always keep our plantations fully supplied. The only and great difference which our orange gardens present is this: that we have no longer old and large trees in our plantations; you can no longer count upon handing your orange-trees over to your children.

74. Lagrima is not a disease that we are likely to be troubled with in North New Zealand, as our climate is so equable. I stated in a former paragraph that the climate of North Auckland was, if anything, better adapted for orange-growing than that of New South Wales, being subject to neither drought nor excess of rain; and now, to show the actual difference in the rainfall of the two colonies, I give the following figures, which speak for themselves: The mean annual rainfall of Auckland, computed from 1866 to 1881, was 45·306in.; the greatest rainfall in any year was 53·180in. In 1860—the year lagrima appeared at Parramatta—there was a rainfall of 72·938in., whereas the mean rainfall is not more than 40in. At Sydney the same year, the rainfall was 82·801in., and in 1864 72·120in., while in 1862 it was only 23·980in. These great fluctuations from dryness to moistness, implying extremes of heat and cold, brought about the lagrima. I have, I believe, seen either one or two cases of lagrima in my own orchard, the trees being Sydney ones that were planted in "holes," set deep, and otherwise not properly attended to. But, with proper cultivation and drainage, it is a disease that should never be known in this climate unless the trees are planted in heavy clay land.

75. "Foot-rot" is a more common disease, and cases of it are very prevalent in this district, particularly where little attention is paid to the cultivation of the tree. Foot-rot, as above explained, is the sloughing and decay of the bark just underneath the surface. It may be induced by a variety of causes: by deep setting, by stagnant water around the roots, by fermenting manures around the base of the trunk, or by the roots coming in contact with poisonous earth. I have lost a number of trees from foot-rot. Three very fine lemon-trees I killed by placing stable manure against the bark of the trees. I have also lost trees with foot-rot from deep setting. A gentleman residing close to Whangarei showed me the stem and roots of a lemon-tree that had died on his farm. The roots of the tree were perfect, but a ring of the bark of the

stem just above the collar had wholly disappeared. The tree had been too deeply set from two to three inches. Either that caused the death of the tree, or the presence of fermenting manures in the ground caused the bark to rot. The same gentleman lost a number of trees in a similar manner.

76. If planters will keep the crown roots exposed to the atmosphere, they will not be troubled much with foot-rot. Anything that tends to retard the growth of the tree predisposes it to foot-rot, as the sap of the orange abounds in oil and starch, which, in combination with watery particles, favour easy and rapid fermentation, especially when the circulation is slow. Drainage is most important in this connection, as, if water be allowed to stand on the surface or a little below it, under the influence of a powerful sun, fermentation speedily sets in, and a few weeks or months thereafter the roots of the tree resting therein begin to show signs of decay. If under-draining is impracticable, good surface drainage should be had, and the land well mulched to keep down the temperature, and thus check fermentation. The first indication of foot-rot is when the leaves begin to turn yellow. The bark facing the sun should be immediately looked to, and, if found to be affected, so much as is diseased should be cut out, and the wound whitewashed and filled up with fresh cow-dung. If the bark has rotted all round the stem, the tree cannot be saved without considerable trouble, and unless it is a large fruiting tree it is better to plant a fresh tree in its place. I have saved such trees by putting a bandage around the wound, but the recovery is very slow. The poisonous fungus which in volcanic lands attaches itself to and kills the roots of fruit trees is not peculiar to this colony, being well known in the Azores. An authority there, writing on the subject, says that the only known cure is to cut out the affected roots and expose the others to the air for a short time.

DIE-BACK.

77. A disease known as the die-back, and very common wherever the orange-tree is grown, is thus referred to by Moore:—

Perhaps the most formidable disease which has yet made its appearance is the "die-back." The name "die-back" is a general term, used, for want of a better and more specific name or names, for at least two diseases arising from three and perhaps four different causes. But, as it is descriptive of the symptoms of one or more diseases arising from several different causes, its meaning is readily comprehended. The symptom is the dying-back of the new wood to the old. It is sometimes confined to a few branches of the tree. When this is the case the inference is that it is caused solely from the sting of an insect. If, however, the symptom is

general to the young branches, and they come forth feeble and yellow, with no mark of stings, the cause *may* originate near the roots.

Deep planting will produce such symptoms. Trees do not depend solely upon their leaves for the supply of carbonic acid. The roots gather a very considerable part of this gas, so essential to plant-life, not in a pure state, as is done by the leaf, but in chemical combination with other elements. This is the case especially with trees which have very yellow roots. Such trees send their roots either into very porous soil easily penetrated by the air, or else send them near the surface, where they find a greater abundance of air, which decomposes manure and is essential to the formation of carbonic acid. Such is the case with the orange-tree and roots. If the tree is planted too deep, or the crust on the top of the soil has become very compact, these roots, dependent upon air for health and ability to perform their functions, are virtually smothered. They make an effort to grow, but, as often as they form rootlets and root-hairs, these die and convey no nutriment for the formation of the *woody* structure of young shoots; so the new and tender cells, which are but the frame-work of the plant, perish for want of support. And hence the light cellular structure, in the form of young shoots, dies back as certainly as if it had been cut from the older wood. I have occasionally dug up trees so afflicted, and found them wanting in new roots. The remedy is to reset, or else take away the top soil till the lateral roots are brought near the surface; and to keep the soil well cultivated. Cut away all diseased wood and roots.

MANURING THE ORANGE-TREE.

78. This subject is the most difficult to deal with, more especially as the majority of planters, and particularly young ones, take it for granted that the orange-tree is a ravenous feeder and cannot be given too much manure. To upset what I am convinced is a popular fallacy is no easy task, but the data which are adduced in the foregoing will enable persons to form their opinions from something like correct premisses. The matter has to be viewed from two distinct standpoints, namely,—

(1.) Whether the tree is to be cultivated with a view to its longevity and the production of the best description of fruit; or,

(2.) Whether the tree is to be cultivated under the "forcing" system, with a view to early returns, regardless of quality or of the longevity of the tree.

Under the first system, very little manure is used; the trees bear smaller crops, but the fruit goes on improving: the tree continues to grow and will live for centuries. Under the second system, the trees are brought into premature bearing: they bear heavily for a few years, then languish, and either die or lead a sickly life. Under the first system, the value of the orangery goes on increasing for ever; even after the trees have grown as large as their surface space will permit them, the fruit with the age of the tree always improves, and such an orangery can with certainty be handed down from gene-

ration to generation. Under the second system, the goose that lays the golden eggs is strangled prematurely; the orangery may or may not be made to return a large sum annually for a given number of years. The result is problematical, and the measure of success very doubtful, while the probability of being able to hand such an orangery down to one's children is very small.

79. In no other country where the orange is grown are fertilizers used to such a large extent as in Australia, and the cause is apparent. In the early days of orange-growing in New South Wales, the fruit fetched a very small price. In fact, the industry as an industry was at a very low ebb. All at once a market for the fruit opened itself in Melbourne, and the fruit became so valuable that everybody wanted to produce it, and, without any other thought than that of squeezing the golden eggs out of the goose, the growers jumped at the conclusion that the best thing for them to do would be to manure their trees—force them at any cost, so as to get the high prices then offering. The practice then adopted settled down into a habit, and to this day many of the New South Wales planters follow out this plan, with the result that their oranges are now of inferior quality and their trees are very short-lived. The reason for this result is easily divined. Many people assume that the orange-tree is a ravenous feeder and cannot be given too much manure; but people who argue this way assume that the tree obtains the bulk of its food from the soil. That possibly may account for what is undoubtedly a popular fallacy.

80. The bulk of all vegetable growth consists of organic substance, and it has been demonstrated that the greater portion is derived from the atmosphere by absorption through the pores of the foliage. A proportion is, of course, also obtained from the soil, but less is taken from the soil than from the atmosphere, and that proportion is rendered all the smaller by the thorough cultivation of the soil, so as to permit of the free circulation of the air and moisture—elements necessary to induce nitrification, or the dissolving of chemical constituents in the soil, which makes them available for plant-food. There is also another consideration to be borne in mind—namely, that it is the natural habit of some plants to subsist to a much larger extent than others on the atmosphere than on the soil.

81. Artificial manure can invariably enlarge the crop, but not necessarily improve the quality of the fruit. The wine-making grape, for instance, prefers a soil that is not very rich. One of the best authorities on this subject, referring to this point, makes the matter very clear. He says,—

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Lupines in some parts of France are sown among vines, and buried when in flower round their roots, where they decay—a practice found to be of singular utility to the crops. A good dressing may be obtained in various old earths from meadows or woods, of a different quality from those of the vineyard: one dressing of this kind *will last ten years*, and keep the vine in bearing. . . Many *obstinately use rich dressing* in a considerable quantity, and injure the fruit. The wine made from vines so treated is apt to turn ropy, and be ill-flavoured. The leaves in a year or two acquire a yellow tint, the stems decay, and there is no resource but to renew the vineyard. A moderate dressing only should be given. The decayed branches of the vine itself, the simple leaves of most vegetable substances, such as broom, brier, thorn, lucerne, and several kinds of grasses, are observed to fertilize the vine. Marine weeds must be used very sparingly; so must animal manure. . . . Some of the finest dry wines are grown where . . . *no dressing is ever used*, especially where the soil is calcareous. A little road mud, old vegetable earth, and the calcareous wreck of ruined houses, sparingly *used once in five years*, are said to have proved beneficial in Germany.

82. From the above it will be seen what a small amount of nourishment is required by some plants: that such plants derive the bulk of their sustenance from the atmosphere there can be no doubt. That the orange-tree comes under this class of plants there can also be no doubt, and no better evidence could be found than that supplied by Jose de Canto, of the Azores, in his letter to the Director of the Botanic Gardens, Sydney. After referring to the appearance of the "lagrima" in the Azores (his reference to which appears in a previous chapter), he goes on to say,—

A great revolution has taken place in consequence of this disease in the culture of our orange-trees. In old times the orange-trees *wanted no culture at all*. The old trees produced abundant crops of the most beautiful thin-skinned fruit, well ripened by exposure to the sun and a free circulation of the air. Since the appearance of this disease, however, we shelter our orange-trees very much against the winds, and this shelter (procured by the plantation of rows of large trees) prevents, as a matter of course, the free circulation of the air, the free passage of the light, and the direct action of the sun. We manure our gardens with common court manure (stable manure), sea-weeds, and lime; and we trench underground a green crop of white lupines, which promotes a considerable amount of vegetation. The consequences are a great development of the productive power of the tree—abundant crops, *but of a very inferior kind*. The oranges are *no longer thin-skinned*, and no more of that deep golden colour and inviting aspect which formerly distinguished them. They have also *lost much of their reputation* in the English markets, and the *durability* of the fruit has been lessened. Forty years ago we could send our fruit to Norway and to Russia, and now our fruits will scarcely *arrive in England in good condition after a fortnight's passage*. So we are returning once more to some of the old traditional culture. We are clearing the shelters, pruning the interior of the trees for the admittance of air and light, are *less liberal with supplies* of manure, and do our utmost to get the ground under the tree free of weeds, except when we want to excite vegetation. We have abandoned the propagating by layers, and graft

good chosen kinds upon seedling stocks. For shelters we give preference to trees that have not a thick foliage, and take care not to let them grow too high.

83. From this report it will be seen that even with stable-dung, sea-weeds, and lime, the trees were injured. What then would be the consequence if large quantities of bone-dust were used, or, as is sometimes the case, a dead beast were buried at the foot of a tree? This gentleman states that in the Azores they discovered the errors of their ways, and were now less liberal with supplies of manures. To get a clearer conception of this subject, it will be well perhaps to consider the bulk of an orange crop. The weight of an orange crop from an acre of ground is about two-thirds that of mangolds, or twenty tons as against thirty; and the amount of manure given to an acre of mangolds is 5cwt. of guano, but the chemical composition of a mangold and that of an orange are vastly different. One contains more of the elements of the soil than the other, while, too, the orange-tree by its large upper growth has an immense absorbent surface which the mangold has not. The roots of the tree also penetrate to a much greater depth.

84. All local evidence goes unquestionably to prove that manuring the orange-tree is not esesntial. The numerous old seedling trees in the North Auckland district, which at the present time are bearing so heavily, not only received no manure but very little cultivation. They were grown more as shrubs than with any idea of their fruiting, and hence were not looked after in the most kindly manner. Yet they have done well and bear prolifically. Mr. R. Sissons, in 1884, took twelve hundred oranges from a tree in his orchard which, he informed me, was never manured till lately, and the amount applied had been very small. Dozens of similar instances could be noted. On the other hand, there are some trees at the old Whangarei Nursery which were literally embedded in manure—a huge heap of broken bones, &c., being piled up the stems of the trees. These trees have attained a fair size, and bear very well, but the fruit produced by the trees is not nearly so sweet as that taken from trees that have not been manured. Any one who would compare the growth and produce of these trees with the old "seedlings" would see at once that "heaps of manure" had not got them in advance of trees grown without any aid. Heavy manuring forced the trees at the nursery into early bearing, but this early bearing means the stoppage of the trees' growth, and, consequently, instead of tending to increase the produce, actually limits it by stunting the growth of the trees.

85. In all orange-growing countries, the bulk of the planters

resort to manure only to a small degree, though there are here and there planters who advocate manuring *ad infinitum*. But, without exception, all experienced planters are agreed that artificial manures are the worst for the orange-tree, in that they are too stimulating or spasmodic. None of them contain in the right proportion all the elements needed for the orange, and many contain elements that are injurious. In the previous paragraph I pointed out that in the Azores even manuring with stable-dung, lime, and sea-weeds had been found to be injurious. In Portugal the practice is to top-dress with a compost every alternate year. In a little pamphlet, which the veteran orange-grower, Mr. Pye, of Parramatta, gave me, I find the following, which was written some years ago:—

For the past thirty or forty years Mr. Pye has experimented with every variety of manure, and the result of his investigations has been to impress him strongly in favour of Peruvian guano; but even of that he uses but little, having more faith in suitable soil, well taken care of, and, above all things, kept free from weeds, than in any artificial stimulant. Many visitors to the Rocky Hall estate are under the impression that much of what they see is due to the plentiful use of manure. Such is not the case, for during the past twelve months Mr. Pye has only used, in addition to the small quantity of farmyard manure from the estate itself, a single ton of Peruvian guano.

86. Even these views he has modified with time, as he told me that he never applied guano to a tree unless it was looking sickly, and then he gave the tree a dose as medicine. In reply to my query, previously put, as to whether he was in favour of heavy manuring, he said emphatically, No, and likened the effect to a man taking too much alcohol: the effect was both stimulating and elevating, but the process was destructive of the constitution. Because a glass of whiskey does a man no harm, it does not follow that a bottle would not, while it is quite certain a gallon or two would kill him. So it is with the orange-tree: a little mild manure might invigorate, but an excess of undiluted "spirit" would kill.

87. A tree can eat too much just as well as Pickwick's fat boy, and when the "expanding causes" exceed the powers of the fibres the accumulation creates disease, and the mass, yielding to the decay of nature, returns to the earth. The following extract from the pamphlet just mentioned further corroborates the previous remarks:—

What strikes the eye, as soon as it has fully appreciated the regularity of the rows and the healthy appearance of the trees, is their uniformity of height, showing how thoroughly an equality of growth has been maintained, and how well the system of drainage has suited. Next in order we find nine rows of seedling trees of the second year's planting, or eight

years old. These, slightly smaller than the first lot, present the same collective features, while individually they are models of what an orange-tree ought to be. At this part of the orchard the water only runs off one way, viz., to the south, but the system of surface-drainage is as complete and as successful as where the ground trends to north and south from the top of the ridge. In the south-east corner of the orangery is a plantation of eight-year-old apple-trees, "doing remarkably well." The entire area of the orchard is fourteen acres, of which ten acres are devoted to orange-trees and four to apples. *No manure whatever* is used, nor is there the slightest sign of disease. This, considering the fact that the land has been *seventy-five years in cultivation*, shows beyond all doubt its valuable quality. Our attention was particularly drawn to nineteen small blood orange-trees, which this year produced no less than sixty cases of fruit—a wonderful yield indeed, considering the size of the trees. Many of the larger trees are as symmetrical as though regularly clipped to keep them in shape, while for colour of foliage and cleanliness of bark it would be difficult to find their equals. From these results, and the fact that the soil here is so diametrically opposed in quality to that of the Rocky Hall estate, where, as here, surface-drainage is the only method of drainage adopted, Mr. Pye argues that, for the culture of the orange, surface-draining is far superior to subsoil-draining. When we take into consideration the fact that in many subsoil-drained orangeries the trees are sickly and dying, which those at Rocky Hall and the Old Farm are in a perfect state of health, we cannot but give weight to Mr. Pye's argument. It remains for the theoretical and practical orange-growers to settle the question amongst them.

This was written by a reporter of the *Sydney Morning Herald* ten or fifteen years ago, and Mr. Pye told me he could give me no further information, excepting that of late years he had adopted the plan of mulching his trees with forest leaves, which acted as a manure, kept the weeds down, and prevented the ground from becoming too dry.

88. Notwithstanding the success that has attended Mr. Pye's system—pursued on two vastly different soils, *i.e.*, a "light sandy" soil and a "stiff black" soil—many Australian planters went in heavily for manuring. Some succeeded fairly well for a time, others failed altogether, and none beat Mr. Pye. Mr. Holroyd, for instance, trenched his ground and put very coarse bones in the ground when planting the trees. The trees grew with great rapidity—were forced, in fact—and were attacked very badly with disease. A rank growth predisposes the sap of trees to the attacks of certain insects. Mr. R. E. McIntosh, a grower of twenty years' experience, said,—

Whenever bone-dust, guano, or boiling-down manure is used, I have invariably seen it the case that when the trees should be yielding the most benefit they are dying out—when they should be at the highest state of perfection they are dying out. I do not think the red and black scale had been so troublesome as since bone-dust and guano had been extensively used. I know one person who objected to stable manure as being too stimulating and destroying the trees, which, in fact, it does

if you use too much of it. I have entirely escaped lagrima, and I have so little scale that it is of no concern whatever; any tree that has them, I can get it rid of them in two months: but not from any application—not from any wash or anything I put on, which in fifty cases out of sixty does more harm than good; I merely go to the tree and look at it, and if it is not in a good condition, and the ground is very hard round, I slacken it, and put some cooling manure to the roots—virgin soil is about the best.

Do you know any other orchard that has escaped?—Yes; every poor man's orchard nearly. The poor man's orchard will grow, and the rich man's will not.

The rich man gives too much manure?—Yes; too much bone-dust and guano. The orange is a slow-growing tree, and requires little manure. I have seen persons from Italy, who say the manure used there is generally from the cow-yard, kept for many years before it is applied to the trees. Why virgin soil is so good as manure for orange-trees is partly because it contains what is generally neglected, and that is a great quantity of fibre—decomposed ferns, leaves, and grasses. Virgin soil is principally composed of this vegetable matter. I do not think it does much benefit in preventing evaporation, but as a cooling manure it is of the highest value; and a load of bush soil would do more for an orange-tree than a hundredweight of guano. If the use of bone-dust and guano is persisted in, it will ruin half the orange-trees in the colony.

Mr. Devlin, another very old planter, who manured his orange-trees with stuff from boiling-down establishments, lost the whole of his trees during the appearance of the "lagrima"—an orchard which brought him in from £1,000 to £1,200 a year. Giving evidence before a Select Committee subsequently, he said: "I do not think the trees require so much manuring. . . . . After they commence bearing they require something to *nourish* them; when they produce a great quantity of fruit they require nourishment."

89. Now the rub is, "What is nourishment?" That is where the doctors disagree. Mr. Holroyd said, "Orange-trees never want manuring or forcing, but only nourishment." His nourishment consisted of putting into the ground a quantity of bones half the size of one's hand to nourish the trees for six or seven years, but even with this plan the trees were attacked with disease. It is perfectly clear that, whatever "nourishment" is given, it must be of the mildest kind and slow to take effect. Any artificial manure is out of the question. Leaf-mould is undoubtedly the best and safest, as consisting of nothing but decomposed vegetable matter. Another equally safe and cheap fertilizer is the muck to be found in rivers, creeks, and lakes, which abound in the forest lands of the North. The muck should be spread broadcast and ploughed in, care being taken not to pile it so high as to smother the roots. Where none of these fertilizers are handy, green manuring is the next best and safest plan. Leguminous plants, such as peas and beans, should be chosen for the purpose

when practicable, as their substance contains a large percentage of lime, while the largest proportion of the residuum of the orange-tree is superphosphate of lime.

ANALYSIS OF THE ORANGE.

90. G. W. Davis, an American writer on orange-culture, gives the following analysis of the fruit, made by the editor of the *Boston Journal of Chemistry* :—

The skin weighed 67·5 grams, which is 23·33 per cent. The seeds weighed 7 grams, which is 2·84 per cent. The pulp weighed 182 grams, which is 83·83 per cent. The skin contained in 100 parts: Water and volatile oil, 78·00; organic matter, 21·36; ash, ·64. The seed contained in 100 parts: Water, 50·00; organic matter, 48·64; ash, 1·36. The pulp contained in 100 parts: Water, 90·90; organic matter, 8·68; ash, ·33. The pulp contained in 100 parts: Grape sugar, 4·3; cane sugar, 4·2; in free acid, 1·0. The free acid consisted of about equal parts of malic and citric acid. The ash constituents of the orange were as follows: Potash, 38·7; soda, 7·6; lime, 23·0; magnesia, 6·5; ferric phosphate, 1·7; sulphur, 2·9; silica, 6·2; phosphoric acid, 14·1. The attention of the orange-grower need only be given to the ash constituents, as these contain the inorganic elements necessary to be applied to the soil when deficient. It will be noticed that potash, lime, soda, magnesia, and phosphoric acid are the most important elements likely to be needed; and those which are most soluble, as potash, soda, and magnesia, should be more frequently applied.

INSECTS INJURIOUS TO THE ORANGE-TREE.

91. Their names are legion. But the most formidable enemies are the scale or coccus and the borer. Woodlice and crickets will bark the tree. Caterpillars and grasshoppers will nip out the young shoots. The cicada or big locust rips the bark of the young limbs open to the sap, and high winds snap the injured limb off at the wound, and the egg of the cicada is deposited in the cut. The shell snails eat the leaves of the trees, and do great harm. I have picked as many as sixty off one little three-year-old tree. The only way to deal with these pests is to handpick them. The same blight that affects cabbage may sometimes be found on the young tender shoots. There are certain flies that sting the trees and cause "die-back" of the limbs; but, not being an entomologist, I cannot designate them. There are other flies which, on the reverse, are useful in feeding upon pests. We will now take the different insects separately, noticing the scale and borer last.

92. Grasshoppers and Caterpillars.—As a general rule neither of these pests are common to the orange-tree or give much trouble; but they can be very destructive. Mr. P. S. Brown, of Ngunguru, planted two hundred trees last year, and as soon as shoots came upon the trees they fell off. For months Mr. Brown searched the trees and could never find

anything but ants* upon them, and he persisted that the ants did the mischief, though other planters whose trees had hundreds of ants upon them never lost their shoots as described. At last, a friend found a green grasshopper upon one of the trees, and upon further search being made a large number were discovered. These grasshoppers are of the exact colour of the foliage of the tree, and are very, very difficult to discover. You might spend an hour in searching a small tree for one, and then the pest would still be upon the tree. Last year, all the shoots of one of my own trees were found on the ground one morning, and after a very long search a green caterpillar was found upon the tree. This insect was also of the exact colour of the foliage and very hard to find. The best plan is to shake the tree well, or bring the syringe into play, and often insects are dislodged this way. Subsequently, I found some young shoots at the foot of a tree, and upon syringing the tree a green grasshopper was placed *hors de combat*. The only instance I ever heard of these insects doing any serious harm in this district is the case in point, and Mr. Brown assures me that although his trees are in the best of health not one of them was allowed to put on a new shoot. I have come across the following reference to this matter by an American writer:—

There are many insects which are more or less injurious to the welfare and successful cultivation of an orange grove. Among the many, the grasshopper plays a conspicuous part. They exist in countless thousands, and live by devouring the leaves of the trees and young succulent shoots. There are several varieties which prey upon the leaves; but perhaps the meanest of all the tribe is the green flying insect commonly known as the katydid. These creatures will destroy and mutilate about as great an amount of leaves as the silkworm, and accomplish the task in an incredibly short space of time. The common brown grasshoppers are also numerous, but not so ravenous as katys. The only effectual remedy are the birds and a flock of fowls. These useful helps are to be highly commended, and should receive every encouragement to do their duty, by not feeding them much of anything except what they get in the range. It will not do to feed fowls much if you wish them to do their duty in an orange grove.

93. I would remark that fowls and ducks may be an advantage in one way in an orangery, but my experience is that fowls scratch large holes at the foot of orange-trees and expose the fibre-roots, and ducks will permit nothing in the shape of peas or beans to grow, so that, if you wish to cultivate vege-

*Ants may be regarded as one of the fruit-growers' best friends. They live principally on the excretions of other insects, and juices and sweets which exude from injured fruits and plants. They are always attendant on the scale insects, and are a sure guide to affected trees.

tables amongst your trees, you cannot keep poultry; and I do not think the grasshoppers will ever get so plentiful here as above described. The Ichneumon is death on the grasshopper, and, as this fly is plentiful, the grasshopper will be at a discount.

94. Woodlice and Crickets.—Both of these are sometimes found barking the trees at the surface of the ground, the latter being particularly destructive on clay land during a dry summer. To keep the ground around the trees well broken and forked, instead of allowing it to cake and crack, is the best preventive. Woodlice are harboured by placing mulch near the stem of the tree. A writer, referring to the last mentioned, says,—

> The woodlouse, or white ant, has occasioned serious trouble and sometimes death to many fine young trees where the preventive was not used—*ashes or slaked lime around the base of the trunk.* When the tree begins suddenly to show yellow leaves, examine a few inches below the surface at the base of the trunk for woodlice, especially if a stake has been driven near the tree for its support, or if litter from the forest or mulching of leaves has been used. If woodlice are discovered, clear them away carefully, and pour boiling water into the cavity around the tree until all the cavities in which the lice could have concealed themselves have been reached. If the tree has been but partially girdled it will recover, if the soil be placed above the wounded part. But, if the tree has been completely girdled, get well-rotted muck and pile it for three or four inches above the wound, and cover over with sand. Finish with a top-dressing of fresh wood-ashes or slaked lime. If the tree is not too far spent it will send out young roots above the wound, and finally recover.

Crickets may be destroyed with arsenic in mixture with cooked apples, or oatmeal flavoured with aniseed. Rhubarb leaves are said to be poisonous to them.

95. Cabbage-Blight, Thrip, etc. — For these there is nothing better than Gishurst's compound, which may be obtained at any nurseryman's store.

96. The Cicada. — From the want of a work on New Zealand entomology, orchardists have great difficulty in discriminating between useful and injurious insects, and also in knowing the precise habits of the pests. Of the cicada I cannot obtain definite information, nor can I state with any positiveness that the big locust that plays such havoc with our fruit-trees is not what is known in America as the Periodical or Seventeen-year Cicada. But of one thing I am quite certain, and that is that the cicada or big locust which infests our orchards is quite as destructive as the seventeen-year cicada. This insect is fully described in Treat's fine American work on "Injurious Insects." The big clacking locust is too well known to need description. There is no known method of dealing with the insect; but certain spiders sometimes "land" them.

The female cicada cuts innumerable slits into the limbs of trees and deposits her eggs, which number from four to five hundred. From fifteen to twenty eggs are put into each nest, so that it will be seen that one cicada does immense harm. The limb so punctured often snaps off with the first high wind. The peculiarity of the seventeen-year cicada is that the young when hatched descend the tree into the earth, generally following the roots, the juice of which they suck, and remain underground for seventeen years. There are, howevever, annual broods. Orange-trees are very subject to the visits of cicada, and many of the young limbs are rasped into by this very destructive pest.

THE SCALE OR COCCUS.

97. Orchardists generally seem to know very little about this most formidable of all fruit pests. It is not confined to the orange-tree, but is now in this district attacking the plum- and pear-trees, and unless checked it will prove as disastrous as the *oïdium* has been to the grape-vine. We can no longer grow with success any of the European varieties of the vine in the open because of the *oïdium;* the peach-tree, too, most people give up as a "bad case" owing to the aphides and "curl," to which it has become a prey. The pear and plum have for some years been subject to the leech disease, and now the scale makes its appearance. The scale insect, though, that is attacking the pear- and plum-trees, is not the same as that peculiar to the orange-tree, but the treatment for both is the same. It is a small scurfy scale that attacks the pear- and plum-trees, and may be found on nearly every bud, and all up and down the limbs. Of course it reduces the crop of fruit to a minimum, and will, if not checked, stop the trees from fruiting altogether. It is, Mr. Maskell informs me, the *Diaspis santali.* It is indigenous to the New Zealand bush, and may be seen on the maire tree.

98. The United States Government some time ago appointed a special Commission to inquire into the subject, and a very voluminous volume was published by Dr. Comstock as the result, referring to which a Californian paper says,—

The space devoted to insects that infest the orange-tree is a sad commentary upon the evils of neglect and ignorance, through which heavy expenses are now made necessary in nearly every orange-growing district. But, in the course of investigations about insect enemies of the orange, it was found that the scale insects *(Coccidæ)* did most of the harm, so that nearly a hundred out of the hundred and fifty pages of the full report are devoted to that subject, including also the scale insects which ravage deciduous fruit-trees and many sorts of ornamental plants. As a class,

these insects form the most incessant, powerful, vexatious, and costly enemies of our orchards, orangeries, gardens, and conservatories. Taken collectively, it would seem that they do more harm to horticultural interests than any other single agency or enemy. The mealy bug ravages alike the pet window-plant of the shop-girl and the costly green-house of the professional florist; the oyster-shell bark-louse shortens alike the farmer's crop of baking-apples, and the orchardist's twenty-acre field of yellow Newton Pippins; the orange scales trouble amateur and colonist, rich and poor, if he only have a Citrus fruit-tree. The universality of danger and loss makes the subject at present, and for years to come, one of great importance.

99. Another Californian journal, referring to the subject, says,—

The *Coccidæ* are unattractive and difficult to study, and few men have taken up this branch of entomology. Dr. Comstock spent three months on the Pacific Coast and in Utah collecting scale insects, and able assistants have continued this work. Many of the orange-trees were colonized on small trees in pots, and their life histories were studied as carefully as possible. There are four divisions of the *Coccidæ* family, differing in habits and metamorphoses. The scientific names are: *Diaspinæ* (example, the red orange scale); *Brachyscelinæ*, or Australian gall-insects; *Lecaninæ*, such as the black scale of California, and the useful lac insect; the *Coccinæ* or mealy bug, such as the cochineal insect. It is not possible in the limits of a brief article to define the characteristics and changes, at various periods of their existence, of these different insects. They are so minute that the best instruments are required, and the classification of the species has been attended with endless difficulties.

What is now known as the red scale of California was introduced on lemon-trees imported from Australia. The colour varies from greenish yellow to reddish brown. It is much dreaded by orange orchardists, and has done incalculable injury in some noted groves of the southern counties of California. It infests trunk, leaves, limbs, and fruit. The leaves sometimes turn yellow and fall. It is probably the greatest enemy of the Citrus family. In a warm climate there are five or six generations in a year. This gives a glimpse of the rapidity with which this frightful plague can spread. The red scale of Florida is found in but one grove there, but is common in Cuba. It is a dangerous enemy to young trees, and disfigures the fruit of older plantations, making it less marketable.

The scurfy bark-louse is common in apple and pear orchards in this State. There are several species of bark-louse found on the wild willow-trees along the stream, from which they undoubtedly spread to cultivated trees and plants, and do much injury.

The pine-leaf scale is found upon conifers, and particularly on pine-trees in the forests. The white oak of Southern California is sometimes covered with a yellowish or white scale insect peculiar to that tree.

The oyster-shell bark-louse does harm in deciduous orchards. The Lecanium class of these—the Coccidæ—include two, *Hesperidum* and *Hemisphæricum*, which are found in the State upon palms, green-house plants, and the orange-trees. *Lecanium oleæ* is the black scale of California, and is a serious enemy to contend against. It infests Citrus trees, pomegranate, deciduous fruit-trees, ash, eucalyptus, jessamine, and many garden plants. There is seldom more than one brood a year.

100. The scale insects known here to orange-growers have been identified by Mr. W. M. Maskell, to whom I sent speci-

mens, as the *Lecanium oleæ* and the *Lecanium hesperidum*. The scale of the black or *L. oleæ* is about the size of a small black pea cut in twain; the insects themselves are microscopical. It infests some of our indigenous trees, such as the puriri, for instance, and it causes the leaves to be covered with a sooty appearance. Of itself this sooty fungoid growth does no harm, but proves the presence of black scale. Lime dusted over the tree will clean the leaves. The *hesperidum* scale is smaller, and is to the eye just like a louse. It is more injurious than the black, and breeds much more quickly. I have seen it cover a limb in a week as if it were a solid scab. When the scale first makes its appearance on the limb it is no bigger than half a pin's head, and, being transparent, only a practised eye would detect it. As the eggs underneath go on developing, the scale or covering expands, and the scale assumes a more distinct appearance. First it is only a white filmy covering, through which the green bark is visible; then it assumes a yellowish-green colour, and later on a brownish-red appearance. At this stage, if the scale be lifted, the insects will be found to be in motion. They are no bigger than grains of flour, and look very pretty under the microscope. So far I have never seen the *red* scale of Australia on trees in this colony.

101. Moore, in referring to the scale, says,—

The insect which at one time was considered the most injurious was the long scale insect, resembling one side of a distorted muscle-shell, and was called by Packard *Aspidiotus gloverii*. When it first made its appearance in Florida it threatened universal destruction of the orange groves. It first made its appearance at Mandarin, Florida, about forty years ago, to which place it was brought on some China orange-plants freshly imported from China. The insect is very diminutive, and under a glass of strong power has the appearance of a white louse. It is very quick in its motion (its movements resembling those of the chicken-mite), and conceals itself, during the presence of an enemy, under the scale erected for the shelter, first of the egg and then of the young insect. The eggs are purple and laid in two parallel rows. The insect when hatched at once begins to suck the sap—like the aphis—from the bark and leaf of the tree wherever the scale happens to be fastened. It finally develops into a diminutive fly undiscoverable with the natural eye, except when late in the afternoon they can be seen between the observer and the declining sun when the tree infested is suddenly jarred. The effect produced by their sucking is first to deplete and finally to exhaust and kill the branch and leaf to which they cling.

Another insect similar to the one just considered, but with scale of lighter appearance and of rounder form, is also damaging to the trees. This insect seldom attacks either the leaves or the tender wood, but confines itself mainly to the bark of the wood from one to four years old. They are easily and effectively removed by washing the trunks with wood-ashes and water in the proportion of one quart of ashes to three gallons of water. If found generally on the tree in positions not easily reached by

the hand, syringe as before with "white lye"—lye prepared by boiling wood-ashes.*

Another insect resembles, when young, fine corn-meal dusted over the tree, but when the case in which the insects are enclosed is full-grown it resembles the small barnacles clinging to a wharf built in salt water. When these cases are turned over and examined with a glass, they disclose under each a multitude of small insects resembling lice. They do not exhaust trees so rapidly as the scale insect, but their presence is damaging. The leaves of the trees infested change after a while to a dark sooty appearance, and the tree does not grow so rapidly.†

102. The above scale is the black coccus which is common here both on the Citrus tribe and on some indigenous trees. The sooty appearance on the leaves of the trees will be known to most orchardists here. Many have laboured under the impression that it was itself a disease.

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*A most formidable enemy to both these insects named has appeared within the last two years in the grove of the writer. It is a lady-bug with a single red spot on each wing-case. In both the pupa and perfect state it is ever busy devouring these insects. Of course they are allowed full freedom of the grove, and are increasing very rapidly.

Another enemy, noticed for the first time and during the present year in the grove of the writer, of the long scale insect, has appeared in the form of a small hang- or basket-worm, "named by Mr. Packard (as the writer has been informed through the entomological department of the Agricultural Department) *Platæcitis gloverii*," but later named *Psyche confederata*. The female remains in her case and devours insects enclosed under her web. The male is a small dark-coloured moth. These insects are not a very formidable enemy to the scale, as the female confines herself closely in her operations under her web. But some small trees have been entirely rid of insects by their help. But if "these insects," as the entomologist of the Agricultural Department writes, "in their habits resemble the basket- or drop-worm of the North," they might prove an enemy to the orange-tree as well as to the scale insect, and it should not be encouraged.—MOORE. [This basket-worm I have seen on trees here. Its basket sometimes resembles the berry of the tea-tree, and sometimes it is an elongated bag covered with tea-tree leaves.]

† An enemy to this insect also has appeared. I am informed by the entomologists of the Agricultural Department, to whom I send specimens of this and the other insects mentioned, that the "insect is the *Evagoras rubidus*, which destroys the plant-lice on the cotton and orange; at least I have found it in the act of sucking out the juice of a plant-louse." As I finished the above sentence I laid my pen down to go out and capture some of these insects, that I might give a more accurate description, and found a full-grown insect which had just pierced with his proboscis a full-grown house-fly. He continued his feast for a few moments as I watched, and when frightened retreated, carrying his prey with him. This insect when young resembles a red spider. As it increases in size it changes to a salmon-colour with white spots. When half-grown, or about half an inch in length, two small black wings are visible. When full-grown, or three-fourths of an inch in length, two pairs of wings show themselves, the smaller or under pair black, the upper pair black with salmon-coloured marking on the forward halves of the wings. When fully grown the insect is ready for flight, and is very active. When young it is very busy feeding upon *small* insects; when grown it seeks for larger prey.

103. The fly described by Moore as the *Evagoras rubidus* is evidently similar to the Ichneumon, which devours every kind of parasite. My orangery is swarming with them, and very little scale, consequently, is to be seen on my trees. The fly is thus described by Captain Broun in Brett's "Colonist's Guide:" "Distinguished chiefly by the possession of four membranous, transparent wings, and, in the female, by the presence of a conspicuous ovipositor. Many are almost entirely black; others are spotted with white, or broadly banded with red; and one, the most beautiful — the *Pompilius fugax* — is furnished with yellowish wings, a large patch of velvet-like golden pubescence, the rest of the body and limbs being of a yellowish-red colour." This fly, when full-grown, is nearly an inch long. The female fly pierces insects with its ovipositor, and deposits its eggs in such insects. The egg, having been duly lodged, will in time be hatched, and the young ichneumon feeds on the entrails of its victim until it is completely destroyed.

THE CURE FOR SCALE.

104. There are many cures recommended for the scale; but the best of all, according to Mr. Pye, of Parramatta, is Gishurst's compound, diluted according to directions, and applied while the liquid is warm. The objection urged against most other decoctions by experienced growers is that they stop up the pores of the leaves, and, by adhering too long, check for the time the functions of the foliage. The theory appears perfectly tenable, and Mr. Pye goes so far as to have all scale removed from his trees by a hard brush or piece of sacking, and applies Gishurst's compound afterwards. He told me he had tried most of the different compounds, and believed them all, with the exception of Gishurst's, to be injurious to the trees. Soft-soap and such-like compounds not only stuff up the pores of the foliage, but contain elements which are supposed to be injurious to the tree. Mr. Pye recommends Gishurst's compound in the highest terms, stating that it is not only effective in killing all insect life, but has a most beneficial effect upon the tree, which soon becomes apparent from the healthy and glossy appearance of the leaves. This compound I find to be cheaper than even soft-soap. Orchardists will find this the best cure for every kind of insect that infests fruit-trees, and should not fail to try it. It is equally serviceable for the pear- and plum-leech, the peach-aphis and curl, the apple-blight, red spider, thrip, ants, &c. Where this compound cannot be obtained soft-soap can be used, in the proportion of ½lb. to a large bucket of water. The soap-suds from

the house are effectual if applied as soon as the scale first makes its appearance. Lime thrown into the tree at the same stage is likewise effectual if a good dew is upon the leaves. The lime should be thrown from underneath up into the tree, so that it will cover both the under and top sides of the leaves. If the operator has not got a syringe, an ordinary whitewash-brush answers very well for small trees. The concoction should be "flipped" on. When the scale is killed it turns a reddish brown, and falls off when touched. If it is not killed within a week of the first washing, the operation must be repeated. The following remedies have also been used, but are generally condemned: Kerosene with soap-suds, whale-oil soap, vinegar and acetic acid, carbolic acid, tobacco decoction, &c. Gishurst's compound is to the orange-tree what Pears's soap is to the human body—cleansing, refreshing, and invigorating. Other decoctions are to the orange-tree pretty much as cart-grease would be to the human body—as much an aggravation as a remedy of the complaint. The orange-tree is much more subject to the scale than the lemon.

THE BORER.

105. This pest has been very destructive in North Auckland amongst lemon-trees, though it is not generally known in Australia. However, it is one of those nuisances which cultivators of the Citrus tribe will have to look after most vigilantly, and if a proper look-out is kept the borer need cause no anxiety. I have no data to guide me in stating positively where the moth or beetle—whichever it is—lays its egg, but it is a well-ascertained fact that eggs are usually deposited in dead or decaying wood, and, if this were always cut out, there would be less chance of a visit from the borer. As far as my observations go, I am led to believe that the borer or caterpillar (which is like an ordinary wire-worm) develops on the leaf of the tree, because I have cut dozens out of limbs before they had got in more than one or two inches; and I am quite certain that no beetle made the hole, but the worm, or so-called borer. The insect apparently, after commencing upon the leaf, then "bores" into the *new* wood, always selecting the most tender shoots to gain a road into the sap. Its entrance is easily detected. Walk down your grove and look carefully at every tree. If you notice a twig dead or dying, or even sickly-looking, look closely into it and see whether the borer has entered. If it has, there is always a little mound of "borings" outside the hole, or, if the ground is clean, the borings, which are as fine as flour, will be found on the ground. Take your knife and

open the limb down the centre until you reach the borer, or, if the borer has got too far in and you do not wish to disfigure the tree by destroying the limb, syringe salad oil into the hole, and the borer will either get smothered or come out. Another method is to probe the hole with a piece of whalebone. The borer on entering the tree invariably goes downwards, but, on meeting with "difficult country," will return to the entrance, and either goes upwards or makes a fresh start somewhere else. In regard to old trees badly riddled, I would recommend the free use of the saw and the knife. Many trees are allowed to die for the lack of this, which might be converted into fine healthy trees; for it must be borne in mind that no trees answer so well to wholesale pruning as the orange and lemon, if from any cause they have become diseased and sickly. Many persons think that because the borer had gone down into the sap below the surface the tree is past recovery; but that is a fallacy. The borer does not remain *permanently in the tree.*

106. How long it does remain in the tree is a matter which no one has yet discovered. The habits of many other borers are well known. Some remain in trees as long as seven years, others for a shorter period. Captain Broun, in Brett's "Colonist's Guide," designates the borer the larva of a beetle; but the general impression amongst orange-growers is that it is that of a moth; and that is my impression too. I believe it goes through its transformations within a year, and that it is similar in its different phases of metamorphosis to the peach-borer, which, when full-grown, spins for itself a follicle of silk, and thence issues forth a moth. The peach-borer works chiefly under the surface of the ground. In winter, I believe, the Citrus-borer goes into the pupa state, and hence leaves the tree and may be found on the "rolled" leaves in silky cocoons, where it develops into a chrysalis, then falls to the ground, and remains underneath during the winter. The tree is absolutely free from borers in early spring, and all that is necessary to resuscitate the tree is to cut off with a free hand all wounded branches, and the holes made into the trunk may be filled with oil or water and plugged up with a wooden spile to exclude the air. If the holes in the trunk are numerous or serious the top pruning should be very heavy, so as to concentrate the sap-flow as much as possible in the trunk, and the tree should not be allowed to bear for a year. Most excellent results have been obtained in Australia by treating sickly trees in this way. Another very effective way of aiding such trees is root-pruning. The way it is done in Australia is this: A third section of the circumference of the tree is trenched with a

sharp spade at a distance from the stem equal to the spread of the branches; the next year another third is done; and the following year the remaining section. This is done to induce a growth of new roots, which are requisite for a growth of new wood. If these instructions are followed, there need be no fear of a complete recovery of the trees. Trees riddled by the borer suffer greatly from frost, in that the air penetrates the holes and freezes the unprotected sap.

"RUST" OR "MAORI."

107. A disease known in Florida as the "Rust," and in New South Wales as the "Maori," is fully described by Moore, and its causes are clearly explained. I have had no opportunity of studying it fully, and consequently quote Moore *in extenso*:—

Rust has been the cause of considerable annoyance to the growers of the orange in Florida. The writer has for years been engaged in experiments for the purpose of ascertaining, first, the cause of, and then the remedy for, the rust. Some years ago he reached the conclusion that the rust was nothing more than the oxidized oil from the skin spread over the surface. This discovery was first made through the microscope, and afterwards confirmed by chemical tests. The cause of exudation of oil was first attributed to some peculiar condition of the soil. Different remedies were applied with the hope of getting rid of such matter as would produce an excess of hydrocarbonates. Among other things, caustic lime was applied broadcast through the orangery. The rust disappeared for two or three years, and again returned. Eighteen months ago the writer's attention was called, by Mr. W. C. Hargrove, of Palatka, to a microscopic insect first noticed by Mr. J. K. Gates, and believed by them to be the cause of the rust. This led me to investigate in another direction. Knowing Mr. William H. Ashmead, of Jacksonville, Fla., to be investigating insects, I sought his co-operation. He found the insect new to entomologists, but belonging to the order *Acarina*, and family *Phytoptidæ*. Mr. Ashmead gave to the insect the name *Phytoptus oleivorus*, or oil-eating. He has given a very interesting chapter on the subject in his pamphlet on "Orange Insects." The writer, during the two summers last past, has tried a number of experiments, hoping to find a destroyer of the insect and a preventive of rust. He found a strong decoction of tobacco with whale-oil soap, one pound to ten gallons of the decoction, the most effective. This decoction was applied by means of a pump, forcing the liquid through a rose nozzle and drenching the foliage and fruit. The application should be made monthly during May, June, and July, as there are monthly generations of the insect. The present year I found them attached to the fruit as late as October. When there is no fruit on the trees the insects attach themselves to the leaves. Lime, sown broadcast when foliage is damp, is beneficial. The insect is microscopic, and only discoverable with the unaided eye when they are in great abundance upon the fruit or leaves. Then the fruit and leaves have the appearance of having been slightly dusted with the finest flour. I copy description from Mr. Ashmead's work: "Whitish flesh-colour, elongated; gradually increasing in size near the head, it becomes twice as thick as posteriorly; abdomen finely and transversely striate, apparently consisting of numerous very thin segments; at the extremity is a biped appendage that evidently assists it in clinging to the orange; just above

it protrude two caudal filaments; head almost hidden in thorax; four legs rather short, with one claw, a long hair springing from the knee."

When the insect attacks the orange before the fruit is grown it is dwarfed in size and blackened; when attacked later, the colour is changed to a dark bronze; if still later, to a light bronze. The fruit is not otherwise damaged by the "rust." Some claim a benefit from the rust, since "rusted" fruit keeps better and is shipped with less damage. Such fruit is also sweeter, as the watery particles are allowed to escape through the punctured skin, and the saccharine matter thus concentrated. As the oil exudes from the punctures made by the insect and spreads over the surface, it hardens into a varnish which protects the fruit against atmospheric influences. The most available time to attack the rust insect is during the winter, before the trees have put on their new crop of fruit. At that time the insect has fastened itself to the under-side of the leaf. It does not transfer itself to the fruit until the oil-cells are well formed. By lodging on the underside of the leaf it is more difficult to attack. But if caustic and well-slaked lime is applied when the leaves are well dampened with dew—dew is better than the rain, as the rain does not wet the underside of the leaf—the fine particles of lime adhere to the leaves and destroy the insect. The application should be made from beneath the tree, the operator standing near the trunk and throwing the lime in handfuls up among the branches. The same rule should be observed when the tree is washed with a decoction of tobacco and whale-oil soap. It should be first syringed from beneath; afterward it may be showered from the side, and thus by drenching every part of the tree insure a more effectual application and remedy. Another reason why the application of remedies should be made in winter is: The insect does not seem to be multiplying during the colder weather. It certainly is much more active during the warmer months. It should be attacked when at a disadvantage. Every tree in the grove should be treated, and if possible every leaf of every tree in the grove. What would be better still, communities ought to combine and operate at the same time, that the enemy may be exterminated. When once they have obtained a lodgment in a grove they multiply very rapidly during a hot dry spell. An opinion prevails that wet weather increases the rust. This is true to a limited extent. The oil does not exude from the punctures made by the insect till it has removed itself from the puncture or died. As long as it continues to suck the oil the orange does not rust. Should the orange be stimulated to active circulation of sap, the pressure from within induces a more active flow of oil. Hence the rain makes the show of rust the more speedy by first stimulating to an increased flow of oil and then hastening its oxidizing. The rust does not appear simultaneously with the insect, but follows its operations. Hot weather is favourable to the development of the insect, but wet weather increases the show of rust. Sulphate of lime I have found to be a specific for the rust-insect. Two applications should be made during the year—one in the spring before the blooming of the trees, the other during the month of June. The sulphate of lime or land plaster should be applied while the tree is wet, at the rate of from one to two quarts to the tree. The whole of the trunk, branches, and foliage should be well dusted.

ORANGE MARMALADE.

108. The following is the process for making the celebrated Scotch orange marmalade: "Scoop out the pulp of Seville oranges into a hair sieve, beat it, and press the juice through

into a pan below; boil the skins in water in the preserving-pan till they are tender; then take out the white part, and cut them (the outer rind) into small strips; add this to the juice, and to each pound of the fruit add a pound of clarified sugar, and boil the whole for about half an hour to a degree called the *feather*. Take it off, stir and mix it well, and boil again till it hangs to the spoon, being the degree called the *crack*. Take care not to boil it too much, but watch it carefully, as the proper consistence is important. When right, pour it into pots; cover them with paper dipped in brandy, and tie a bladder over it. Common oranges are not equal to the Seville, but they will make very good marmalade. If the sugar is broken in pieces and boiled with the fruit, without first being clarified, it will do; but then it must be skimmed as it boils. Marmalade should be made between July and the end of September, as the Seville oranges are then in their best state." There are many other recipes for making marmalade in vogue, but perhaps none require less work, or make a better article, than the one in question. Half the sugar called for in this and all other recipes for marmalade will suffice, if the boiling and reducing the juice and fruit to the proper consistence is done first, and then adding the sugar after the kettle is removed from the fire. Cane sugar boiled with fruit acids is converted into glucose, or fruit sugar, which has less than half the sweetening properties of cane sugar; hence the sugar should never be boiled with the juice, but added and thoroughly mixed with the fruit juice after it has been evaporated to the proper consistence.

ORANGE WINE.

The following is the process for making orange wine: "The oranges must be perfectly ripe, else the saccharine matter which they contain would not be entirely developed. The oranges are peeled first, then cut in two halves, across and not lengthwise of the cells; the cutting must be done above a tub so as not to lose any juice; both halves are pressed hard by the cutter. A good workman can peel and squeeze a hundred and twenty oranges in one minute. At the time the tub is full of juice and oranges, the whole mass is carried to a press, which must be so close that none of the seeds can escape into the mass (the seeds would give the wine a bitter taste). To each gallon of juice of the sour oranges I added two pounds of the best white sugar, to bitter-sweets one and one-half pounds, and to sweet oranges one pound of the best white sugar, and to each gallon of the mixed juice and sugar one quart of pure water. The whole is put into a barrel, and a

space of about five gallons capacity is left for the expansion of the wine during fermentation. The orange wine has to undergo the lower fermentation, as by the upper fermentation all the volatile matter and the aroma would escape. The barrel must be closed air-tight, and a fermenting-tube adjusted. For the first few days the fermentation is very vigorous, and the barrels must be watched closely to prevent their bursting. After a few days the fermentation subsides gradually; the wine has to be racked off, and the lees can be filtered. The fermenting-tube has to be again adjusted to the new barrel, and has to remain till the fermenting ceases entirely. About six weeks after that period the wine has to be racked off a second time, and in a month or more will be fit for the market, as no second or 'spring' fermentation occurs, as is the case with grape wines. Orange wine is of an amber colour, tastes like dry hock, but retains for ever the aroma of the orange. From the cakes which I took out of the press, I made vinegar, with an addition of water and molasses, which was sold at twenty-five cents per gallon, wholesale; and, from the peels, oil of orange or an extract of orange could be made, and so every particle of that delicious fruit can be utilized. One thousand two hundred sour oranges and one thousand five hundred bitter-sweet or sweet oranges make one barrel of forty-five gallons of wine, and ten gallons of vinegar."

BARREN FRUIT-TREES.

109. In old orchards of fruit of any kind may be found trees which seem to grow thriftily, are mature, and of bearing age, yet seldom produce any fruit. The same will be found to occur in all soils and situations, and among all kinds and varieties of fruit. It is true that some kinds of fruit-trees and some varieties of the same kind are more subject to barrenness than others; but the fact remains, and no satisfactory explanation has yet been promulgated. The phenomenon has been attributed to many causes by various authors who have experimented and written on the subject, but scarcely any two of them ascribe the fault to the same conditions. The orange-tree is no exception to the general rule, and many large trees which are aged and thrifty may be found scattered about in most groves, and solitary, which have produced little or no fruit and failed to perform the important functions which Nature intended them to fulfill.

110. Many remedies have been recommended to cure the evil by those who have given it much attention, such as root-pruning, summer pruning, bending down the branches below

the horizontal to check the flow of sap upwards, girdling, and debarking. The first is attended with a vast amount of labour; besides, it has a tendency to destroy in a measure the equilibrium and vitality of the tree. The second is impracticable to any great extent, or when applied to large trees. The third remedy, "girdling," seems the most rational and practical; is attended with little inconvenience; is sure to accomplish the object; and is not likely to compromise the life or usefulness of the tree, although it has a tendency to dwarf it somewhat. The practice of girdling to produce fruitfulness in barren trees, and also to bring into early bearing and ripening of the fruit on young trees, has been employed by pomologists frequently for the last one hundred years, but not until recently has the method come into extensive use for the purpose. Some of the extensive fruit-growers of the West are using this method to bring their young trees into early bearing with astonishing success. One gentleman, a Mr. Spaulding, of Illinois, has an apple grove of fourteen thousand trees, and has been experimenting with "girdling" to produce early fruitfulness and large fine fruit with such success that last year he girdled three thousand trees in his young grove. A writer, who visited the place recently, describes the result as wonderful—astonishing. Alternate rows of young unbearing trees were girdled in June, 1879, and this year they are loaded to the ground with large fine fruit, while trees alongside of them, not girdled, had little or no fruit on. The effect of girdling is twofold. When early bearing is desired, the ring of bark should be removed while the tree is growing the year before. When increase in size of fruit and early ripening is the object sought, girdling should be performed the same year after the fruit is set. The operation of "girdling" consists in removing a ring of bark from one- to three-eighths of an inch wide entirely around the trunk of the tree or large branches. It may be performed with a knife or saw with the teeth set wide; but the neatest, 'cutest, and most effectual little implement for the business is a tool used by mill- and lumber-men for the purpose of marking lumber. This little instrument is handy to use, does its work neatly, and makes a clean cut one-eighth of an inch wide down to the wood. There is every reason to believe that the practice of girdling on the orange-tree will prove as successful in its results as it has in regard to apple, pear, peach, grape, and other fruits; and those who have recalcitrant orange-trees, which are away along up in their "teens," or out of them in regard to age, and refuse to produce liberally, can bring them to a realizing sense of their duty by the process in question. Objections will be raised to the practice, undoubtedly, as being

unnatural and all that; but the same may be said of many other pomological experiments which have resulted in success. Let us live, in a measure, for the present, and enjoy the fruits of our labours as we go along, and not work and wait through life for the benefit wholly of our grandchildren. Those who wish to try the experiment of girdling, and are a little doubtful about its utility, and liability to harm the trees for future usefulness, may begin on some of the lower branches of the tree, which, if the operation should not succeed to their satisfaction, need to be cut away in the future. In that way no harm will have been done if the process turns out unfavourable.

111. Another method of girdling, or which amounts to the same thing in its results, is performed by ligating the body of the tree or branches, by winding tightly around the part to be girdled a few coils of copper or other wire so tight that the return flow of sap will be effectually impeded. By this last process the bark is not mutilated, but where it is thoroughly done the effects are about the same. Some pomologists recommend excessive fertilizing, enriching the soil by cow-penning, and by applying large quantities of other rich manures during the winter months, contending that in this way both fruit-buds and wood growth may be had at the same time, and the "bearing and off-year" habits of trees done away. The practice may be good on very poor land, but fruit produced by excessive fertilization is generally coarse, insipid, and unsatisfactory.

PROPAGATING.

112. The question is often asked, "What variety of orange-tree is the best to plant?" It is a question which, so far as this colony is concerned, cannot be answered satisfactorily. The orange-tree, on being shifted from its native habitat to a foreign clime, changes its character to a greater or less degree according to the difference in climate and soil it has been used to and those to which it is removed. For instance, the orange of the Azores, known as the St. Michael, was originally from Brazil, but the St. Michael is not like any Brazilian orange. The orange was introduced from some part of Asia into Europe, and the different varieties have taken their names from the districts in which they grow, such as the Seville, Maltese, &c. Each of these has its distinctive character, and is never reproduced in other countries without a marked change. In New South Wales the same thing has happened. The one orange that does best there, and which has its own distinctive character, has been called the Parramatta. No other orange succeeds so well in New South Wales as this local variety.

Every other variety has been planted and tried, but all fail in some way or another: some are shy bearers, others over-bear themselves and produce small fruit; and all are deficient in quality, though in their native climes almost all of them would excel the Paramatta orange. We have yet to discover in this country the orange that will take most kindly to our climate. While it is not to be expected that we can reproduce here any of the leading varieties of oranges true to character, there is no reason to suppose that we shall not be able to produce a local variety as good as any of these. But to do this we must graft our trees with scions from locally-grown trees that have borne the best description of fruit, and unless the trees are so grafted we shall not get good fruit. In any case it is recommended that scions for grafting trees should be taken from fruiting trees, as it is held that they bear earlier than if the scions were taken from non-fruiting trees. It is to be feared, however, that this rule has not been observed in our local nurseries. The mode has been, I understand, to import the different varieties of trees from New South Wales, and graft seedlings from these. There are some very fine seedling trees about the Bay of Islands which produce excellent fruit, and it would be well to graft trees from these, as the quality of the fruit would be assured.

113. In Europe and Florida the trees are budded, but in New South Wales they are grafted. I have not been able to discover any reason why a preference should be given for one process in the Northern Hemisphere and for another in the southern half of the world. There are so many different courses advocated in connection with orange-culture by planters in different countries that one is at a loss to know what to recommend in any particular case. For instance, on the subject of seedling *versus* worked trees there is a great divergence of opinion. Seedling trees are held by some to be the best, Mr. Pye, of Parramatta, being a strong advocate for them. It is contended that they make larger trees, bear more heavily, are less subject to disease, though, of course, they are also longer in coming into bearing. On the other hand, George W. Davis, a Florida writer on the subject, says,—

> Seedlings do not generally come in bearing with any degree of regularity; some trees will bear at seven or eight years old, and all the way up to twenty and twenty-five years: hence the necessity of budding or procuring budded trees when starting a grove, if early fruiting is desired.

The Rev. T. W. Moore, alluding to the same subject, says,—

> As to the relative advantages of seedling and budded trees, each year's experience and observation increase my appreciation of *budded trees*. Were I to plant again, I think I would plant no other.

The great recommendation, however, of worked trees over seedlings is the fact of their coming into bearing the third year after grafting; while seedlings rarely bear at six years old, and may be twenty before they do. Grafted trees only should be planted in this young country. In Europe it is the practice to prevent the trees from bearing till they are six years old; but in these colonies the tree are allowed to bear the fourth year. It is this early bearing, no doubt, that dwarfs the tree in comparison with the seedling tree, and not the mere act of grafting.

114. The common mode of grafting the orange-tree is that known as cleft-grafting, and it should be done towards the end of September or in the beginning of November. The following description of cleft-grafting I take from that very excellent work, "Brett's Colonists' Guide:"—

If the orange stock and scion do not differ in size more than usual, the latter generally grows over the top of the stock, so that eventually the two are united all round, and a smooth trunk, bearing very slight indications of the union, results. The method of performing cleft-grafting is as follows: The stock is split by a chisel and mallet; before the chisel is withdrawn, a wooden wedge, rather larger than the scion, is inserted to keep the split open until the scion is in its place. The wedge is then withdrawn, a tie is put around the stock, and grafting-clay over all, not omitting the top. In grafting large stocks two scions are sometimes placed on the opposite sides of the stock. In preparing the scions for insertion, when two are to be used, they must be of somewhat different shape from single scions intended for large stocks. If the operator will insert one shoot the edges of the cleft will nearly go together, leaving the opening across the top somewhat tapering, as well as the perpendicular cut. The single scion, then, must be cut wedge-shaped in both directions; when two are to be used in one stock they will require to be tapered only in one direction. There must be no bruising of the bark either of the stock or scion. In order to avoid this, a very thin slice may be taken off the bark edge of the scion or off the edges of the cleft in the stock before the scion is inserted.

115. Orange pips should be planted in July, and they should never be allowed to get too dry before planting. The usual method of keeping pips till planting-time is to put them in sand. It is urged by Mr. Moore, of the Sydney Botanic Gardens, that the Seville orange makes the best stock, and he instances many places in Spain where the Seville tree is growing though all other sorts have been killed by disease. There is plenty of evidence to support Mr. Moore's theory that the Seville is the hardiest of all trees, and is the least subject to disease. But it is a very slow grower, and for that reason it finds but little favour. In fact, the stock which is known to be the most productive of disease, the lemon stock, is the most popular in New South Wales, for the reason that it is a vigorous grower, makes a tree the soonest, and produces the quickest return. A good grafted lemon stock will grow into a tree twice as fast as a

grafted orange stock, produce soon and heavily, and die young (twenty years old and upwards), while the orange grafted on its own stock will live to a good old age. The bed in which the pips are planted should be well prepared and trenched.

Lemons are easily raised by layering, and this system answers as well as any other if the grower has a few good bushy trees. Some nurserymen adopt no other plan for raising lemon-trees.

SPECIES, VARIETIES, ETC.

116. Little need be said here on this head, further than that there are but four distinct species in the family, the innumerable names quoted in catalogues being of local origin. Gallesio recognizes but four distinct species in the family: the orange (sweet), the bigarade (sour orange), the citron, and the lemon. He justly remarks as to the varieties,—

The Citrus is a genus whose species are greatly disposed to blend together, and whose flower shows great facility for receiving extraordinary fecundation; it hence offers an infinite number of different races which ornament our gardens, and whose vague and indefinite names fill the catalogues. Gray remarks, "The species or varieties are much confused and mixed." Reese in his quotations from authorities makes a similar confession.

117. In Australia, the St. Michael is considered an over-prolific bearer, tending to exhaust itself early. The Navel is a shy bearer, but the best of fruit. The Emperor of China Mandarin is the best of its class, and ranks as first-class in all orangeries. The Canton Mandarin has the defect of only bearing full crops in alternate years. The Maltese Oval is said to ripen its fruit earlier in the season than any other tree. For profit, the Parramatta is considered far and away the best in Australia. The Poor Man's Orange is only good for preserving. The Cumquat is very small, and is also a preserving fruit. The Cluster has the peculiarity of the fruit growing in clusters at the end of the branches. Mandarin oranges are also called Tangierine, Kid Glove, and Tomato. The Seville orange is very sour with bitter rind, and is only used for marmalade, &c. It is the original wild orange or bigarade. Speaking of the four distinct species, Gallesio says,—

The Orange of Portugal, or common sweet orange, is a tree growing to a great height when raised from seed. Its leaf is green, having a winged petiole; its shoots are whitish; its flowers entirely white and very odorous, though not equal in perfume to those of the bigarade.

Its fruit, ordinarily round, is sometimes flattened, sometimes a little oblong. The rind, less than an eighth of an inch in thickness, is of a reddish yellow, and full of aroma; the inner skin is a sallow white, spongy, and light. The sections, nine to eleven in number, contain a sweet juice, very refreshing and agreeable; its seeds are white and oblong, germinating

very easily, and reproducing usually the species with little change. There is a variety with no thorns; it is the race cultivated mostly by grafting, and is seen in all countries where this method of propagation is followed. In places where the orange is grown from seed it is rare to find it deprived of thorns.

The China Orange is a variety excelling all others in the perfection of fruit, of which the juice is the sweetest, the most abundant, and the most perfumed. The skin is always smooth, glossy, and so thin that one can scarcely detach it from the pulp. This is characteristic of this variety.

The Red-fruited Orange is a singular variety. Its appearance, its leaf, its flower, are all exactly like the common orange. Its fruit alone is distinguished by a colour of blood, which develops itself gradually and like flakes. When the fruit begins to ripen it is like other oranges; little by little, spots of blood-colour appear in its pulp; as it advances to maturity, these enlarge, becoming deeper, and finally embrace all the pulp and spread to the skin, which is, however, but rarely covered by the peculiar colour; yet this sometimes occurs if oranges are left upon the trees after the month of May.

This orange is multiplied only by grafts, having few seeds, and those of little value. This is a proof that it is a monster; if it were the type of a species it would yield more seed and reproduce itself by seed. Its branches are without thorns; its fruit is sweet, but less so than the China orange, and it has thicker skin. It is cultivated largely in Malta and Provence. In Liguria it is found chiefly among amateurs and seedsmen.

118. The following, taken from American works, describes the characteristics of the oranges in these colonies:—

Tangierine Orange: Synonyms—Mandarin, Kid Glove, Tomato Orange. —Size medium; much flattened; colour dark orange; broad irregular cavity, with stem obliquely inserted and surrounded by a knobby eminence; eye set in a large depression one inch wide and five-sixteenths deep; longitudinal diameter two and a half inches; transverse diameter three inches; skin irregularly ribbed or lobed; colour of flesh very dark orange; pulp adhering to skin by a few filaments; sections of pulp easily separated; pulp coarse; juice sweet and highly aromatic; quality first.

Navel Orange: Synonyms—Umbilical, Bahia, Pernambuco, Seedless Orange, Embiguo.—Size large to very large; eye presenting an umbilical appearance (from which it obtains its name); stem inserted in a shallow-ribbed cavity with deep lines; skin three-sixteenths thick; longitudinal diameter three and five-eighths, transverse three and three-quarters; flesh very fine, melting, and tender; juice sweet, sprightly, vinous, aromatic; quality, first. Origin, Bahia, Brazil.

Bergamot.—Form flattened, with projecting nipple; colour deep lemon; eye absent, and its place occupied by a nipple-like projection; stem inserted in a slight depression; skin two-sixteenths; longitudinal diameter through nipple three inches, transverse three inches; colour of pulp nearly white; juice sweet and watery, without any decided flavour; rind possesses a pear-like fragrance, from which perfumers obtain their bergamot essences. Only worthy of cultivation as a curiosity.

St. Michael's.—Medium size, round pale yellow, seedless; skin thin; pulp sweet and delicious; tree prolific; one of the best; imported from the Island of St. Michael, one of the Azores.

Maltese Blood.—Fruit large, sweet, juicy, and seedless. It is distinguished by the blood-red colour of the pulp; this appears in the form of flakes when the fruit begins to ripen, which gradually increases until the entire pulp is coloured. The tree is thornless. Introduced from the Island of Malta, where it is largely cultivated.

ORANGE-CULTIVATION IN FIJI.

119. With a view of checking the information I obtained in Australia, I communicated with the Colonial Secretary of Fiji, so as to ascertain whether the method of cultivation as pursued there agreed with that followed in New South Wales. The attached correspondence resulted from that communication, and speaks for itself.

I would remark, however, that this communication is very important as demonstrating: (1) That manuring the orange-tree is not essential; (2) that where the tree is neither troubled from frost nor from cold winds it grows so luxuriantly as to be almost free from the attacks of scale; (3) that the rainfall has little to do with the health of the tree. Fiji is the natural habitat of the orange, and there it grows wild in the most luxuriant manner. It requires neither cultivation, manure, nor shelter. It depends solely on an abundance of heat and humidity, free from frost and cold winds, or anything to check the continual flow of sap. Being always healthy and vigorous, no disease ever attacks it, and it grows into an immense tree, yielding four to five times the crop that it does in Australia, where it is artificially cultivated. Mr. Storck's paper is highly instructive as showing the point to which the orange-growers require to pay most attention, namely, selecting a warm situation, protected from frost and cold winds. Where the tree is exposed to the cold, its flow of sap is checked, and it becomes predisposed to the attacks of insects. An abundance of rain is beneficial to the orange-tree where the rain falls as it does in Fiji, in the summer months, from January to March; but when it falls in winter it is extremely injurious. Hence in Fiji, with a rainfall of 160 inches, the orange-tree is in its true element; "but," says Mr. Storck, "the trees succeed well in other districts where the rainfall is only one-half the above." In Spain, where the rainfall is nearly as great as it is in North Auckland, they irrigate the orange-tree during the hot summer months, and it is a wonder to me that they do not follow that plan in Australia. In California, with a rainfall of only 17·46 inches annually, the orange is grown successfully by keeping the ground well worked. In Florida the rainfall is 54·72.

ORANGE-CULTIVATION IN FIJI.—BY JACOB P. STORCK.

In the absence of any attempt at the regular cultivation of the orange-tree in this colony, the writer here simply records a series of experiences as they have presented themselves to him during a number of years of casual observation, and without any specific data to go upon. The orange crop of this country

has hitherto been of so little economic value that nobody took any interest in its cultivation or in statistics connected with its collection for commercial purposes. The various attempts made to find a market for this produce in New Zealand have, owing to several causes foreign to the subject of this paper, proved almost as many failures financially, and have thus left no encouragement for the grower.

With the exception of a few instances of importations of improved kinds from the Australian Colonies all the orange-trees in the country are the progeny of some seeds brought here from Tahiti by one of an earlier generation of settlers some fifty or sixty years ago. Twenty years ago orange-trees were only met with in a number of native villages on the banks of the Rewa and Narua Rivers. Since then they have been planted by the white settlers around their houses and homesteads, and here and there as a bordering of plantation roads, in which position they have turned out rather a nuisance than otherwise. In Fijiian native villages the trees have always been planted in the most primitive manner, and on the plantations of the whites the trees simply shared the benefits of the periodical weedings and sometimes ploughing of the surrounding crops.

120. The manuring the trees receive in native villages and around white settlers' houses in the shape of ashes and other offal can only be considered as accidental; whilst on the fertile alluvial plantation grounds no manuring has as yet been necessary, owing partly to the fact that practically the whole crop was hitherto allowed to perish where it dropped.

The trees are invariably seedlings, either sown *in situ* or collected anywhere for planting out. The propagation by grafting from improved kinds by the writer of this is probably the only exception to the rule. For stocks the self-sown seedlings of the common orange or of the wild shaddock were used, and answered apparently equally well. They were side-grafted at from four to six inches above the ground. Root-grafting is to be discouraged in tropical or subtropical climates, as trees grown in that manner are seldom long-lived. The roots of citron or lime are incapable of sufficient expansion for the support of a tree so much superior in stature to their own species, firstly; and, secondly, the formation of a crown of roots by the scion, which seems in that practice chiefly to be relied upon, very seldom takes place in a manner perfect enough for the sustenance of a durable tree.

Grafts sometimes bear in the second year; seedlings often in the fourth or fifth; but it is only after four or five years more that, with increased volume of crown and quantity and maturity

of bearing wood, they could be said to produce a crop. At that age, say ten years, a well-formed tree may bear from three to five thousand fruit, and so on increasingly on to twelve or fifteen thousand and more when twenty or thirty years old.

Shelter with orange-trees here is as much a matter of accident as manuring and drainage. In and around native villages they grow amongst breadfruit and other trees, and between the native huts, all of which form a sufficient protection against high winds. But there are quite as many or more trees now, healthier in appearance and of better formation, out on the open canefields and hillsides without any shelter at all. The trade-winds of the tropics are seldom strong enough to injure blossom or young crop; and even against high hurricane-like gales the roots of the orange-tree afford sufficient resistance, and it is chiefly badly-grown, forked trees which then succumb by splitting open. The greater part of the crop at such a visitation is, of course, blown off or hopelessly bruised. The proper artificial shelter for a grove of orange-trees would, to the writer's mind, be a belt of tall trees, four to five deep. The breezes passing through under them would afford the necessary ventilation for the enclosed area, and if necessary a thin screen of trees of a more open habit of growth might be planted just inside of the belt of taller trees to moderate the effects of any strong breezes. The taller trees are meant to extend protection for a distance. Too close shelter without ventilation favours the harbouring of scale insects and smut.

The orange crop begins to ripen about the middle of February, and continues until sometimes the end of July, when the last of the fruit may be seen shrivelling on the outside branches, if there has not been a blow to knock them about, when they will not last as long by a month.

There is also an intermediate crop observed on older trees, which ripens from October to Christmas, but only amounts to a few dozen fruit per tree.

121. Where the growth of the orange-tree is so spontaneous and luxuriant as it is here, there is scarcely any perceptible difference in the health, strength, and size of the trees. They are seen to succeed in stiff volcanic clay soil on hill-sides, on the opener and richer soils at the foot of hills or spurs, along banks of creeks, and on alluvial flats. But perhaps the finest trees may be met with on the banks of the flats, where the trees have natural drainage and lighter soil than farther away from the river. The fruit from trees in volcanic soil on hill-sides is supposed to take longer before it becomes sweet, but to be more full in flavour and rich when ripe than those grown on alluvial soil, which seem to become eatable sooner than the

other, being less sour and more watery. On alluvial soil the fruit is generally quite sweet and eatable as soon as fully formed, although still green; whilst on a hillside it remains tart and sour until it turns yellow. In either situation, however, the fruit which attains its full *natural* ripeness, even up to the shrivelling stage, may favourably compare with any of its kind in the world.

122. Diseases and ravages by insects the orange-tree is sometimes subject to are scarcely known here. Black and white scale-bug are sometimes seen, but the trees cannot be said to suffer from either: whenever they appear to do so it is in consequence of the physical condition of the tree, brought about by accidental mutilation or disturbance of the roots, or the sickening of an individual tree in a low situation, through want of drainage: mere flooding, sometimes for the duration of a week, does not seem to affect them under favourable conditions of drainage. Drainage here generally is an accident of position—for instance, on the edge of the old moats surrounding the native villages, or in a well-drained block of sugar land on a plantation.

The fruit of the orange should not be picked before it is fully formed. It is only in that stage that the rind is sufficiently substantial to prevent rapid shrinkage, and to afford its eatable contents that protection and a certain degree of nourishment still required for the attainment of anything approaching perfection. At the above stage, the interior of the orange when cut through ought to be of an amber colour, a shade or two paler or a shade darker, or with a greenish tint like some wines, according to the different varieties.

123. The mean rainfall in the Rewa and Navua districts—where orange-trees are most plentiful because earliest introduced—is about 160 inches; but the trees succeed well in other districts where the rainfall is only one-half of the above annually.

ADDENDUM.

LAND SUITABLE FOR ORANGE-GROWING.

124. I have obtained from the Government Museum the analysis of some soil taken from Mr. Pye's celebrated Rocky Hall Orangery, Parramatta. It will be remembered that I stated, when alluding to Mr. Pye's orangery, that the soil seemed to be pure sand, and I was so struck with the apparent incongruity of oranges growing so well on such soil that I got Mr. Pye to send some to Dr. Hector for analysis. Mr. Pye is one of those who believe that the orange does not want much manure, but well-worked soil, and plenty of heat and moisture. The analysis below shows that he is right.

RESULTS OF ANALYSIS OF SPECIMEN No. 3906.

Forwarded by Mr. G. Alderton, of Auckland; locality, Rocky Hall Estate, Parramatta, N.S.W.; received, 10th November, 1884; reported on, 11th December, 1884.

Soils I. and II.

This, as shown by the analysis, is nearly pure quartz sand, and so is a singularly barren soil; the part soluble in acid is principally iron, alumina, and silica.

I.—*Soil.*

Water	1·21
Organic matter	1·44
Substances soluble in dilute acid (*a*)	0·61
Clay	0·22
Fine sand (*b*)	21·69
Coarse sand	74·83
	100·00

(*a*) Composition of part soluble in acid:—

Silica	0·154
Iron sesquioxide	0·298
Alumina	0·114
Lime	0·024
Magnesia	0·010
Phosphoric acid	Traces
Alkalies	0·011
	0·611

(*b*) The sand is principally quartz.

II.—*Subsoil.*

Is very similar to the soil, except that it is a little coarser.

W. SKEY,
N.Z. Geological Survey Laboratory,

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